THE REPUBLIC OF TURKEY
BAHÇEŞEHİR UNIVERSITY

EVALUATION OF THE INDOOR SPACE EXPERIENCE THROUGH THE SOUNDSCAPE PERCEPTION APPROACH: CASE STUDY ARCHITECTURE STUDIOS

Master's Thesis

MANAL EL FAKIR

ISTANBUL, 2019

THE REPUBLIC OF TURKEY
BAHÇEŞEHİR UNIVERSITY

GRADUATE SCHOOL OF NATURAL AND APPLIED SCIENCES
ARCHITECTURE (ENGLISH, THESIS) MASTER PROGRAM

EVALUATION OF THE INDOOR SPACE EXPERIENCE THROUGH THE SOUNDSCAPE PERCEPTION APPROACH: CASE STUDY ARCHITECTURE STUDIOS

Master's Thesis

MANAL EL FAKIR

Supervisor: ASSIST. PROF. DR. MINE DINCER

ISTANBUL, 2019

THE REPUBLIC OF TURKEY
BAHÇEŞEHİR UNIVERSITY

THE GRADUATE SCHOOL OF NATURAL AND APPLIED SCIENCES
ARCHITECTURE MASTER PROGRAM

Name of the thesis: Evaluation of the indoor space experience through the soundscape perception approach: case study architecture studios

Name / Last Name of the Student: Manal EL FAKIR

Date of the Defense of Thesis: 27/05/2019

The thesis has been approved by the Graduate School of Natural and Applied Sciences.

Assist. Prof. Dr. Yücel Batu SALMAN
Graduate School Director

I certify that this thesis meets all the requirements as a thesis for the degree of Master of Science.

Prof. Dr. Emine Özen EYÜCE
Program Coordinator

This is to certify that we have read this thesis and we find it fully adequate in scope, quality and content, as a thesis for the degree of Master of Science.

Examining Committee Members	Signature
Thesis Supervisor Assist. Prof. Dr. Mine DINCER	---------------------------------
Member Assist. Prof. Dr. Melek Elif SOMER	---------------------------------
Member Assist. Prof. Dr. Derya ÇAKIR AYDIN	---------------------------------

To my Parents, Sisters, and Family

ABSTRACT

EVALUATION OF THE INDOOR SPACE EXPERIENCE THROUGH THE SOUNDSCAPE PERCEPTION APPROACH: CASE STUDY ARCHITECTURE STUDIOS

Manal El FAKIR

Architecture Master Program (English, Thesis)

Thesis Supervisor: Assist. Prof. Dr. Mine DINCER

May 2019, 81 Pages

Sound is an important element in space experience and it highly influences our daily life. Recently a rising interest in the acoustic ecology has been noticed, which is defined as the study of the relationship between human beings and their acoustical environment. In addition to the objective measurements such as noise control and sonic environment parameters that can be defining a soundscape, the user's sensory experience in the built entity is also an important element in the process of the acoustic environment evaluation. The recent findings regarding the soundscape approach suggest that soundscape occurs through user's perception. On the other hand, the contextual conditions are also important as they are affecting the auditory perception of the users. Therefore, it is clearly understood that sound and space correlation play an important role in how humans perceive and experience the quality of an environment or a specific space. With this in hand, an evaluation of the existing interaction between the contextual experience and the acoustic perception is required. The aim of this thesis is to investigate the indoor space experience in Bahçeşehir University's architecture studios through the soundscape approach. Ultimately, the question that can be posed then is how does architecture students' perception of their acoustical environment in the studio affect their space experience? In order to answer this question, an adapted framework of factors affecting the perception and experience of sound and space was proposed; and indoor soundscape questionnaire was designed and applied in this thesis. 191 students have participated in the survey. Results of the questionnaire were statistically evaluated and presented. The demographical factors effect on the user's perception and experience of their space has been revealed. Furthermore, several statistically significant correlations between sound sources and space factors were reported and interpreted, indicating how the soundscape perception and space experience concepts are affected by each another.

Keywords: Sound, space, perception, experience, soundscape.

ÖZET

İŞİTSEL PEYZAJ YAKLAŞIMI ÜZERINDEN İÇ MEKAN DENEYİMİNİN DEĞERLENDİRİLMESİ: MİMARLIK STÜDYOSU ÖRNEĞİ

Manal El FAKIR

Mimarlık Yüksek Lisans Programı (İngilizce - Tezli)

Tez Danışmanı: Dr. Öğr. Üyesi Mine DINCER

Mayıs 2019, 81 Sayfa

Mekan deneyimi genellikle görsel açıdan değerlendirilir ve görme duyusuyla ilişkilendirilmiştir. Fakat işitme duyusunun da mekan deneyiminde büyük bir etkisi vardır. Ses, mekan deneyiminde önemli bir unsurdur ve günlük yaşamımızı oldukça etkiler. Akustik ortam değerlendirme sürecinde objektif ölçümler önemlidir, ek olarak, insanların mekanda duyusal deneyimi de etkilidir. İşitsel peyzaj yaklaşımı, bu değerlendirmeyi kullanıcıların algıları üzerinden gerçekleştirmektedir. Ses ve mekan arasındaki ilişkinin, insanların bir ortamın veya belirli bir mekanın kalitesini nasıl algıladığı ve deneyimlediği konusunda önemli bir rol oynadığı açıkça anlaşılmaktadır. Bununla birlikte, mekansal algı ve akustik algı arasındaki mevcut etkileşimin değerlendirilmesi gerekmektedir. Bu tezin amacı mimarlık stüdyolarındaki iç mekan deneyimini işitsel peyzaj yaklaşımıyla incelemektir. Bu kapsamda, mimarlık öğrencilerinin stüdyodaki akustik ortamı nasıl algıladıklarını incelemek için işitsel peyzaj anketi hazırlanmış ve uygulanmıştır. Özel olarak tasarlanan bu iç mekan değerlendirme anketi, farklı mekan ve ses değişkenleri içermektedir. Anket sonuçları istatistiksel olarak değerlendirilmiş ve sunulmuştur. Son olarak, değerlendirilen değişkenler arasındaki bulunan anlamlı istatistiksel korelasyonlar bu tezde bildirilmiş ve yorumlanmıştır.

Anahtar Kelimeler: Ses, mekan deneyimi, işitsel peyzaj, akustik algı.

CONTENTS

TABLES .... **VIII**

FIGURES .... **IX**

1. INTRODUCTION **1**

1.1 SUBJECT OF THE STUDY **1**

1.2 SCOPE OF THE STUDY **3**

1.3 LIMITATION OF THE STUDY **3**

2. LITERATURE REVIEW **4**

2.1. EVALUATION OF THE SOUND ENVIRONMENT **4**

2.1.1. Psychoacoustic parameters ***7***

2.1.2. Urban soundscape ***8***

2.1.3. Indoor soundscape ***10***

2.2. SOUND PERCEPTION & SPACE EXPERIENCE **11**

2.2.1. Soundscape perception ***11***

2.2.2. Space experience ***13***

2.3. METHODS FOR EVALUATING SOUNDSCAPE **15**

2.3.1. Outdoor soundscape evaluation ***15***

2.3.2. Indoor soundscape evaluation ***17***

3. METHODOLOGY **20**

3.1. CASE STUDY SELECTION **20**

3.2. QUESTIONNAIRE **22**

3.2.1. Questionnaire design ***22***

3.2.2. Execution ***30***

3.3. EVALUATION **30**

4. IMPLEMENTATION **32**

4.1. THE SELECTED ARCHITECTURAL STUDIO AND PARTICIPANTS **32**

4.2. EXECUTION OF THE QUESTIONNAIRE **33**

4.3. RESULTS OF THE QUESTIONNAIRE 34
4.4. FINDINGS AND DISCUSSION 62

5. CONCLUSION 74

REFERENCES .... ERROR! BOOKMARK NOT DEFINED.

TABLES

Table 3.1: Demographical information……………..……………......................................25

Table 3.2. Factors rated according to the importance level to evaluate Space Experience……..25

Table 3.3. Factors rated according to the quality level to evaluate Space Experience……..26

Table 3.4. Sound sources rated according to the annoyance level to evaluate Soundscape Perception……..28

Table 3.5. Sound sources rated according to the preference level to evaluate Soundscape Perception……..29

Table 4.1: Spearman 's correlations between space experience factors regarding Importance………………..…..50

Table 4.2: Spearman 's correlations between space experience factors regarding Quality……………...…...52

Table 4.3: Spearman 's correlations between space experience factors regarding Importance and Quality………………...53

Table 4.4: Spearman 's correlations between sound sources Annoyance……………....54

Table 4.5: Spearman 's correlations between sound sources Preference/Disturbance…54

Table 4.6: Spearman 's correlations between space experience factors and sound source perception based on space experience………………..................................57

Table 4.7: Spearman 's correlations between sound source perception and space experience factors based on sound sources……………..……...................60

FIGURES

Figure 2.1: Differences between the Environmental Noise and Soundscape management of the acoustic environments…………..…………......................................6

Figure 2.2: Factors of soundscape perception model…………...…………...................13

Figure 2.3: Factors of soundscape perception…..14

Figure 2.4: Methods to assess the soundscapes of urban outdoor spaces…………........17

Figure 2.5: Variables of the indoor soundscape framework……...................................18

Figure 3.1: 6th floor plan of the Architectural studio classroom of Bahçeşehir University, North campus……...21

Figure 3.2: The adapted framework of the soundscape perception, space experience, and demographical factors used in this study……...23

Figure 3.3: Sound source types evaluated within the designed indoor soundscape……...24

Figure 4.1: Time spent percentages defined by three categories: <8h, =8h, >8h……...35

Figure 4.2: Averages of the Space Experience factors rated according to their importance……...36

Figure 4.3: Averages of the Space Experience factors rated according to their quality…………………………………………………………………...36

Figure 4.4: Averages of the Soundscape Perception sources according to Annoyance ratings……..37

Figure 4.5: Averages of the Soundscape Perception sources according to Preference/ Disturbance ratings……………………..…..……....................................38

Figure 4.6: Expectation ratings regarding the Importance of the space factors showing significant differences in terms of gender……………………..…..……....41

Figure 4.7: Expectation ratings regarding the Importance of the space factors showing significant differences in terms of education level…………………………....42

Figure 4.8: Perception ratings regarding annoyance from sound sources showing significant differences in terms of gender……..43

Figure 4.9: Perception ratings regarding the annoyance from sound sources showing significant differences in terms of Education level……................................44

Figure 4.10: Perception ratings regarding the annoyance from sound sources showing significant differences in terms of Time spent……......................................45

Figure 4.11: Reaction ratings regarding the quality of the space factors showing significant differences in terms of education level……................................47

Figure 4.12: Reaction ratings regarding preference/ disturbance from sound sources showing significant differences in terms of gender……..............................48

Figure 4.13: Reaction ratings regarding preference/disturbance from sound sources showing significant differences in terms of education level……...................49

Figure 4.14: Statistically significant correlations between Indoor air quality variable and other space factors evaluated by importance ratings……..............................65

Figure 4.15: Statistically significant correlations between Architecture studio planning in terms of human scale variable and other space factors evaluated by importance ratings……………………..…..……......................................65

Figure 4.16: Statistically significant correlations between Form and function variable and other space factors evaluated by importance ratings……..............................66

Figure 4.17: Statistically significant correlations between Level of acoustic comfort variable and acoustic factors evaluated by quality ratings……......................67

Figure 4.18: Statistically significant correlations between Ability to locate via sounds variable and architectural design factors evaluated by quality ratings……...67

Figure 4.19: Statistically significant correlations between Level of reverberation variable and acoustic factors evaluated by quality ratings……..................................68

Figure 4.20: Statistically significant correlations between the quality and importance ratings of Intelligibility of sounds variable and Level of reverberation variable……..68

Figure 4.21: Statistically significant correlations between Form and function variable and sound sources evaluated by quality ratings……...69

Figure 4.22: Statistically significant correlations between Architecture studio planning in terms of human scale variable and sound sources evaluated by quality ratings……...70

Figure 4.23: Statistically significant correlations between Indoor air quality variable and sound sources evaluated by quality ratings……..70

Figure 4.24: Statistically significant correlations between Level of reverberation variable and sound sources evaluated by importance ratings……..............................71

Figure 4.25: Statistically significant correlations between Groups discussion sound source and space experience factors evaluated by importance ratings……...............72

Figure 4.26: Statistically significant correlations between Individual feedback sound source and space experience factors evaluated by importance ratings……...72

Figure 5.1: Expectation ratings regarding the Importance of the space factors showing demographical variances……..75

Figure 5.2: Perception ratings regarding the annoyance from sound sources showing demographical variances……..76

Figure 5.3: Reaction ratings regarding the quality of the space factors showing demographical variances……..77

Figure 5.4: Reaction ratings regarding preference/disturbance from sound sources showing demographical variances……..77

Figure 5.5: Space experience factors showing statistically significant correlations with other space factors and sound sources……...79

Figure 5.6: Sound sources showing statistically significant correlations with space experience factors……..80

1. INTRODUCTION

1.1 SUBJECT OF THE STUDY

Human beings seek to create comfortable indoor environments and spaces. Architects usually consider visual aspects such as light, materials, and colours as the main elements to create comfortable spaces. The process of experiencing a space is related to our senses, usually the space experience act focuses on the visual aspect, and it has been associated with the sense of sight. However, there is no doubt that the sense of hearing has a large impact during the space experience as well. Even though sound is invisible, it has the ability to reform the features of the space we occupy (Dornburg and Julia 2000). Space experience includes the sense of hearing when experiencing a space and plays a determinative role in how individuals interact with their spatial environment. According to Pallasmaa (2005, p. 49):

> *Sight isolates whereas sound incorporates; vision is directional, whereas sound is omnidirectional. The sense of sight implies exteriority, but sound creates an experience of interiority. I regard an object, but sound approaches me; the eye reaches but the ear receives. Buildings do not react to our gaze, but they do return our sounds back to our ears.*

His perspective helps us understand how sound can be a significant characteristic in the contextual experience. This relation of sound and space will be investigated through the soundscape concept. Soundscape approach was first presented by the writer Schafer who identified soundscape as an acoustic environment consisting of events heard, rather than objects seen (Schafer 1977, p. 7). Soundscape was also defined by the ISO as the acoustic environment perceived or experienced and/or understood by a person or people, in context (International Organization for Standardization, 2014). With this regard, it is assumed that the soundscape approach involves humans understanding of auditory perception and sound environment instead of sound energy (Brown et al. 2011). It has been stated that sounds are identified as a soundscape when they take part of individuals' daily experience (Schafer 1977). Therefore, the concept of perception of the indoor soundscape have a crucial contribution with the space experience, with more focus on the user's conscious interaction with their environment. In addition, researches carried out by several scholars suggested that users’ awareness of the acoustical environment is being given more focus than the sound levels (Brown 2011).

From this point of view, many researchers were interested in searching for different ways of evaluating the soundscapes. The researches presented in the literature under this concept were mostly dealing with the objective variables of evaluation. The soundscape study may be evaluated subjectively as well, as listening to sound sources is an activity that arises by an order from the human mind. The research carried out by Dokmeci and Kang determined the three main aspects of indoor soundscape research as objective analysis, subjective assessment and the built entity. In their article Dokmeci and Kang (2010) claim that, “although objective measurements and parameters are crucial for deciding upon guidelines and palpable findings, there is a need to shift from a physical point of view to a more psychological one. The users with their sensory experience are the key to gather better information regarding the sound environments. This means that in order to conduct an adequate analysis of a soundscape, it is highly demanded to understand the subjective essence considered by humans who experience it (Miller 2013). From this perspective, in order to conduct an acoustical research in enclosed built entities, understanding the soundscape perception concept is one of the crucial points.

Sound elements that are present in the architectural space create an acoustic environment, this latter one requires to be part of an architectural environment in return (Manzo et al. 2010). Thus, sounds interact and intervene in the connections of listeners and context; yet sounds are also influenced by physical, environmental and social elements (Truax 1996). The context is defined as the physical space where the acoustic environments occurs. According to the ISO definition, the context has the ability to impact soundscape over the reaction to the acoustic environment, auditory sensation, the understanding of auditory sensation, and consists of the interconnections among individual, action and place, in space and time (International Organization for Standardization 2014). In addition, space can be recognized as a mixture of colours, shapes and forms, which is valued predominantly by the sense of vision. The association of senses have the ability to identify and create the space experience (Kinayoglu 2009). Acoustic designers and analysts propose that space comprises also of sounds, smells, tastes and textures. With more focus on how people interact with the acoustic environments, a soundscape is able to promote the sense of being somewhere, which equates well with the experience of real spaces. Therefore, the soundscape approach to the management of the acoustic environments became more and more relevant, for its focus on how people actually perceive and experience the acoustic environments (Kang et al. 2016).

The primary aim of this study is to discover the existing interconnection between sound and space through the soundscape approach. Sound perception and space experience are the two keywords investigated through the eye of the occupants of the indoor environment. A framework defining the various factors affecting the sound perception and space experience is introduced and evaluated in this thesis. This framework is tested on a study area and its results are presented.

1.2 SCOPE OF THE STUDY

The study area in this research will be appointed to the architecture studio classrooms of the Faculty of Architecture and Design in Bahçeşehir University. The research will focus on investigating the factors affecting the soundscape perception and indoor space experience by considering the students using the architecture studio classroom as the key element of the study. In order to analyse these concepts a questionnaire form is designed to evaluate the chosen space through the eyes of the occupants, and the impact of the acoustical environment of the architecture studio classroom on architecture students' experience of space.

1.3 LIMITATION OF THE STUDY

Initially, this study will confine itself to investigate the indoor space experience of architecture studio classrooms through the lens of the soundscape concept. The evaluation is limited only to architecture studios in order to investigate a specific type of education environment. The studio classrooms that are selected in this thesis are all within Bahçeşehir University's campus because they share totally identical features. They are divided into two different undergraduate student classes. Only first grade and fourth grade students from the Architecture department were chosen to participate in this research in order to make a comparison according to the perception concept. In addition, the objective measurements of evaluation were not included within this framework.

2. LITERATURE REVIEW

A large range of literature was reviewed under the soundscape framework. Studies in this research field were raised by the pioneers, Schaffer (1977) and Truax (1996). In order to go further in this study, many researches and reviews of previous studies will take place in this thesis to investigate the influence of sound on indoors in relation to architecture.

2.1. EVALUATION OF THE SOUND ENVIRONMENT

Sound evaluation is a complicated framework and numerous disciplines such as physiology, statistics, sociology, psychology and acoustics are related to it. One of the psychological capabilities that is in charge of how individuals perceive their sound environment is listening. Consequently, the evaluation of sound is being investigated subjectively rather than focusing only on the objective parameters. According to the Oxford dictionary definition, psychoacoustics is "a psychology branch that involves the perception of sound and its physiological effects". Several studies thus far have linked the sound perception with psychoacoustic indicators in the frame of the soundscape approach. These studies tended to investigate the environmental noise evaluation process under the psychoacoustics study, which defines sound perception mechanisms from the angle of several parameters such as roughness, loudness, sharpness, tonality, and fluctuation strength. In spite of the fact that sound can be examined and estimated in physical terms and numbers, the entire investigation of sound relies upon the psychoacoustic traits of human hearing.

In a study of psychoacoustic parameters and their role in sound and noise evaluation, Genuit and Fiebig (2005) reported that the subjective noise assessment relies on the receiver's psychological characteristics, the psychoacoustical factors of the human ear, and on the sound's physical conditions. In their article they presented an evaluation study to detect the relevant psychoacoustic parameters that allow the description of environmental noise situations. Genuit and Fiebig (2005) have documented the experiments done under the framework of their research. With the facts revealed thus far they have outlined the complicated relation between the psychoacoustic parameters and human sense. In order to demonstrate the common representation of perception in regard to the known psychoacoustic parameters. Overall, the submitted experiments have shown that a complex consideration of the psychoacoustic aspects of sound is necessary in order to conceive the impact of sound on the human ear and its perception (Genuit and Fiebig 2005). From this point view they (2005) stated that the understanding of noise requires multidimensional methods of evaluation in order to take into account the psychoacoustic parameters (roughness, fluctuation strength, loudness, sharpness), the sound's physical features, in addition to the receiver's social characteristics (Genuit and Fiebig 2005).

In an updated research done by the same authors under the same subject, much attention has been drawn to the effects of psychoacoustics on the soundscape studies. Genuit and Fiebig (2006) introduce the sound evaluation approach under the noise annoyance concept that has been described and studied through the psychoacoustic parameters. By drawing on the environmental noise framework, the writers have been able to show that applying the psychoacoustic parameters and noise annoyance concepts might be considered as a tool to explore the soundscape features. Soundscape is a complex mixture of human, natural, and technical noises and their perception (Genuit and Fiebig 2006). Significantly, the implementation of psychoacoustics in the context of environmental noise enables the achievement of an improved description of the soundscape. The use of psychoacoustic parameters and the detection of temporal and spectral patterns will advance soundscape evaluations as exemplarily shown and will considerably improve perceptually related assessments of the environmental sound quality and its expected annoyance impact (Genuit and Fiebig 2006).

With this regard, the above-mentioned researches' views are grounded on the assumption that sound is evaluated as an unpleasant element in the context of environmental noise. Moreover, the evaluation of the concept sound/noise quality through the environmental noise framework has been discussed by several researchers (Dubois et al. 2004). Noise is defined as an audible sound that bothers the silence or causes annoyance (Genuit and Fiebig 2005). Similarly, in the past years, sound was mostly measured in its epidemiological aspects of 'noise' and most of the international environmental policies focused on noise control (World Health Organization 2011). However, the significant dissimilarity between the environmental noise and the soundscape approach to the acoustic environment design is notably visible, yet they are not contradictory. The soundscape interdisciplinary method to the acoustic environments' management, draw attention to individuals' perception and experience of the acoustic environments and space. In addition to the physical features, the soundscape approach includes the collaboration of human and social sciences, and it treats the environmental sounds as a resource instead of a waste (COST TUD Action TD-0804 2013).

In an investigation into soundscape approach, Brown (2012) outlined the relevant variances in regard to how sound is being conceived, it's relation to people's perception, and how it ought to be thus managed and estimated (Figure 2.1).

Figure 2.1: Differences between the Environmental Noise and Soundscape management of the acoustic environments

Environmental Noise management framework	Soundscape management framework
Sound managed as a *waste*	Sound perceived as a *resource*
Focus on sounds of *discomfort*	Focus on sounds of *preference*
Human response related to sound levels*	Human response often *not* only related to sound levels*
Measures by *integration* across all sound sources	Requires *differentiation* between sound sources
Manages by *reducing* sound levels*	Manages *masking*** unwanted with wanted sounds as well as reducing unwanted sounds

* sound level refers to an equivalent sound pressure level, L_{Aeq} over 10 minutes or more
** masking includes perceptual masking as well as energetic masking

Source: Brown (2012) (Jian Kang, Francesco Aletta, et al., 2016)

It has been pointed out that the environmental noise sector identifies sound as waste element that requires management, in contrast, soundscape studies distinguish sounds from the perspective of preference (Brown, 2012). The actual difference between these two concepts is the diverse human areas of interest. In light of this, Brown (2012) suggests that the fundamental dissimilarity between the environmental noise field and the soundscape field is that the latter puts more efforts on individual's perception, however, the environmental noise approach is more about annoyance. Hence, the objective of a soundscape study is to propose a new understanding to the field of acoustics by considering sounds as resources instead of waste (Dokmeci and Kang, 2016).

2.1.1. Psychoacoustic parameters

Psychoacoustics is a field of research in constant evolving. According to Bosi and Goldberg (2003) it is defined as "the science of sound perception, i.e., studying the statistical relationships between hearing sensations and acoustic stimuli". Psychoacoustics concept has been investigating the connection between the physical properties of sound and the related sensations and feelings to it through humans' perception. This branch of science has been studying sound in accordance to the psychological and physiological aspects. It has been associated to the study of environmental noise, music, speech and soundscape fields. Psychoacoustics covers many fields relatable to sound evaluation. It identifies sound perception process in respect of several parameters. Many researches have investigated the psychoacoustics parameters within the framework of acoustical environment studies. The psychoacoustic perception of an acoustical environment is one of the significant aspects in the subjective assessment of the soundscape research. Therefore, to achieve an improved description of a soundscape, psychoacoustic parameters have to be applied (Genuit and Fiebig 2006). Loudness, sharpness, roughness and fluctuation strength are estimated as the fundamental psychoacoustic descriptors that have been used in several studies. These parameters have been presented as a tool for subjective description of the soundscape. Several studies investigating psychoacoustic parameters have been carried out on the major study of Zwicker and Fastl (2007). Similarly, Segura et al. (2013) presented an analysis about the acoustic comfort created in Catering Premises facilities from the application of psychoacoustic parameters. This study outlines the different parameters of sound quality as an assessment to the acoustic comfort based on Zwicker's nuisance / pleasure models. In the same vein, another research done about restaurant soundscapes has followed the similar path. Lindborg (2015) have engaged psychoacoustic descriptors for analysing the sonic environment of restaurants in Singapore. These studies have outlined a definition for each of the psychoacoustic parameters mentioned in reference to Zwicker and Fastl (2007). In this thesis a brief definition for the primary psychoacoustic parameters is presented below:

a. Loudness (N) is measured in sone, and it is affected by the context and sound nature. It is related to sound volume through the human perception. This parameter belongs to the category of intensity sensations as it measures the intensity of sound (Zwicker and Fastl 2007).

b. Sharpness (S) is measured in acum. It is a sensation which we can consider separately, and it is possible, for example, to compare the sharpness of one sound with the sharpness of another (Zwicker and Fastl 2007). Sharpness can be influenced by other indicators such as loudness and roughness. One of the important features affecting the sensation of sharpness is the spectral content of the sound (Zwicker and Fastl 2007).

c. Roughness (R) is measured in asper. Roughness is again a sensation which we can consider while ignoring other sensations (Zwicker and Fastl 2007). It is also described as a sound design and subjective assessment value. In addition, with a higher roughness, noise emissions are usually annoying and more aggressive and seeming to be more noticeable, even if the loudness or sound pressure level with A-filter are stable (J. Segura et al., 2013). The perception of roughness reaches a peak for modulation frequencies around 70 Hz (Lindborg 2015).

d. Fluctuation strength (F) refers to the sound quality perceived when the individual loudness fluctuations are audible (Deborah et al. 2013). It is given by the signal variations with very low modulation frequencies (Segura et al. 2013). The perception of fluctuation strength reaches a peak for modulation frequencies around 4 Hz (Lindborg 2015). Besides, for modulation frequencies around 20 Hz, there is a transition between the hearing sensation of fluctuation strength and that of roughness; It is a smooth transition rather than a strong border that exists between the two sensations (Zwicker and Fastl 2007).

2.1.2. Urban soundscape

Many of the researches about the soundscape concept that have been previously presented in the literature were related to the urban environment and the city. These researches demonstrate the relation between the soundscape and the overall quality of outdoor spaces. The evaluation of the urban sound environment does not rely upon the visual aspect only, physical, acoustical, architectural, social, and psychological factors are also an important consideration. In addition, this process of evaluation depends on the users' classification of their sonic environment. The outdoor environment consists of various sound zones that define the city's soundscape. It has been proved that the combination of the sound sources in urban areas comprises of natural environment sounds, human activity sounds, and industrial sounds. This variation of sound sources strongly influences the individuals' auditory perception within the urban context. Improving the acoustic comfort feature in urban spaces does not only rely on the diminution of the sound level (de Ruiter 2004). Therefore, investigating human's perception of the urban sound environment may reveal significant results regarding their preferences. Yang and Kang (2005a) study have concluded that people esteemed natural sound sources to be more preferable in an urban square. It has been proved that variances in demographic properties, influence users' classification of an urban space regarding their preferences of the identified sounds within the environment (Yang and Kang 2005a). In addition, a research was conducted by Zhang and Kang (2007) to evaluate nineteen urban open spaces in different countries, has revealed important insights regarding the factors affecting the urban soundscape. Their research has focused on individuals, sound, space and the relation between the physical and acoustical features of the urban environment. They (2007) have concluded that acoustical and physical environment conditions, and the psychological and social characteristics of the public space users play an important role in the urban soundscape evaluation.

Understanding the features of the urban soundscape and how it may contribute in enhancing the urban spaces design, is another aspect that has been presented in the literature. It has been found that the soundscape approach shows a significant role in the development and identity identification of a city (Rehan 2016). Similarly, several authors have conducted some recent researches that aimed at presenting inspiring strategies for the urban soundscape planning and design (Pedrero et al. 2018, Sun et al. 2018, Jennings and Cain 2013). Soundscape dimensions in urban public spaces is another perspective aiming to evaluate the outdoor environment for a better urban experience for people. Following the semantic differential method, Kang and Zhang (2010) have discovered the four factors characterising the soundscape in urban areas. The assessment process of the soundscape evaluation in urban environments requires various methods and approaches, although, several key factors have been identified under this context which are relaxation, communication, spatiality, and dynamics (Zhang and Kang 2010). A number of studies have determined that individual's perception of the various sound elements of the urban environment significantly affect these four soundscape dimensions (Sudarsono et al. 2017, Kang and Zhang 2010). In addition, a recent study by Meng et al. (2018) have concluded significant results from a conducted survey which highlighted that the assessments of relaxation, communication, spatiality, and dynamics differ according to the perceived sounds (natural, human activity, and mechanical sounds), which therefore have a significant effect on the acoustic comfort within an urban space.

2.1.3. Indoor soundscape

The indoor acoustical environment has completely different features and tends to be more complicated than the outdoor space. Despite this, researches about the relation between indoor soundscape and its effects on the indoor space and on individuals as well, are still lacking and needs to be investigated. Sound perception depends on the interaction of humans with acoustical environment. Researches in this context have revealed that poor acoustical design in indoor spaces can highly affect humans and their well-being, which affects backward the space experience. As the space functions change, the users change as well, which makes the different sound source types varies within the indoor environment. These relationships could often be very complex and can have both short-term and long-term impacts on individuals (Babisch 2008; Fisk et al., 2007; Lewtas 2007). Liu and Kang (2016) stated that users' estimation of sound does not rely upon its physical characteristics, but its more associated with the positive and negative actions related to the sound. Thus, the potential role of the sound is highly important in order to create better living and working conditions in any specific indoor. Many studies in this context have focused on the assessment of sound and noise to analyse its impact on the individuals and their space preference. The auditory perception of users differs according to the space architectural features, acoustical factors, and the sound source. It has been found that user's satisfaction and perception of the sound environment effectively influences their interaction with the enclosed environment (Acun and Yilmazer 2018a, Mackrill et al. 2013).

Several researches have investigated various fields such as psychology, sociology, architecture, and acoustics in order to evaluate the indoor sonic environment and its influence on the users. Dokmeci and Kang (2016) have revealed the three key factors to consider in an indoor soundscape study which are built entity which includes several architectural factors, the sound environment factor which consists of acoustic psychoacoustic and physical factors, and then the contextual experience that represent demographic information, psychological and space usage characteristics. Analysing each elements of these factors may help identifying useful findings to improve the soundscape of an enclosed entity. A number of indoor soundscape studies (Segura et al. 2013, Zwicker and Fastl 2007) have focused on the objective measurement as the only method to evaluate the noise annoyance within the enclosed environment. This analysis is based on the acoustic parameters, sound measurements, and the space type. However, previous studies have proved that when the sound pressure level is underneath a certain value (65 ^ 70 dBA), individual's evaluation of the acoustic comfort is more affected by factors such as sound sources types and user's socio-demographic characteristics (Yang and Kang 2005a, Dubois 2000, Maffiolo et al 1997, Ballas 1993, Gaver 1993). Similarly, recent findings (Acun and Yilmazer 2017, Yilmazer and Bora 2017, Watts et al. 2016) have identified the crucial role of examining the psychological and emotional aspects of the users as well as the spatial elements in order to obtain a better understanding of the indoor soundscape.

2.2. SOUND PERCEPTION & SPACE EXPERIENCE

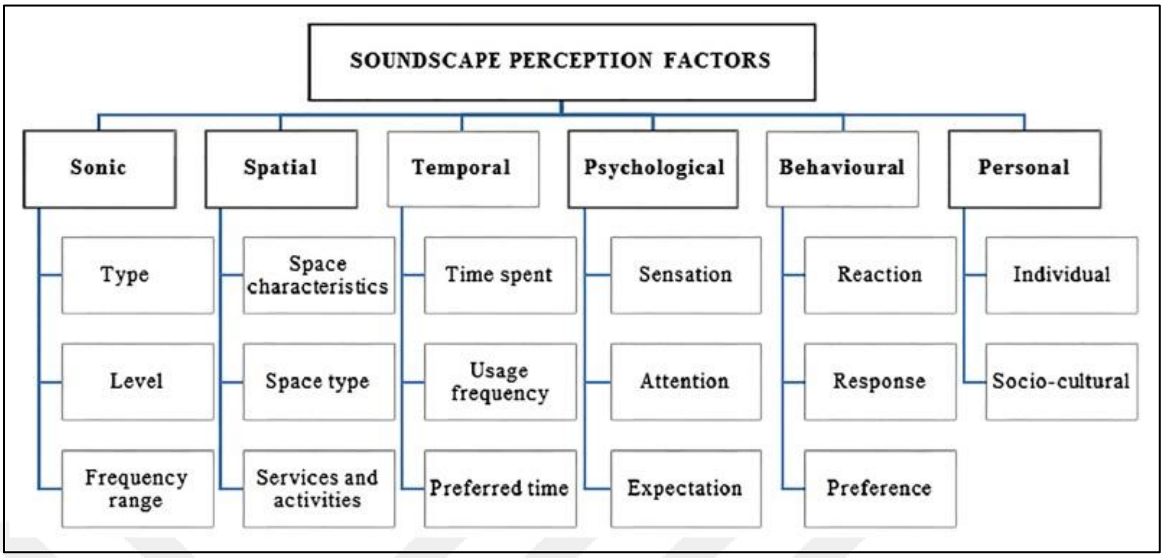
2.2.1. Soundscape perception

Soundscape study is the most common subject reviewed within the field of acoustics. With the objective of examining this concept diverse strategies and methodologies are presented in the literature. Soundscape is a term that labels the interaction of several sound sources which frame the overall sound picture of an area. Thus, in order to identify a soundscape, many variables should be taken into consideration. According to the International Organization for Standardization (2014) Soundscape is notably affected by the acoustical environment and user's socio demographic characteristics, and perception is the element defining it. The audible environment perception can be defined as positive or negative as people's impression differ. Perception rely on expectations, preferences, mood, and actions (Lindborg 2015). We are so familiar with the act of perceiving that the complexity of the process emerges only when we deliberately turn our perceptual talents back on themselves to observe what is going on as we see, hear, smell, taste and touch the world (Genuit and Fiebig 2005, p. 1).

In recent years, there has been an increasing amount of literature on the several categorisations of soundscape perception and space experience factors. Each study differs in terms of evaluation methods and research aim. It was defined by the ISO (2014) the theoretical framework of a soundscape is described according to: user, activity and the used space. Consequentially, those tree elements are being evaluated to understand the crucial relation between them and the soundscape perception. One of the latest researches done in the acoustic filed is an article by Aburawis and Dokmeci (2018a). This article is introducing a synthesize of different previous researches presented in the literature related with the soundscape perception and space experience. It is highlighting the factors affecting the soundscape perception and space experience in several dimensions. Moreover, the user contribution has been taken into consideration in their study, and the investigations have been made accordingly. In addition to the previous literature review that has been discussed in their article under the same concept, a new merged list of the soundscape factors and space experience factors has been proposed, in order to be tested by the acoustical post-occupancy evaluation methodology. The merged factors of soundscape perception were presented as, sonic, spatial, temporal, psychological, behavioural, and personal (Figure 2.2). While the ones for space experience were proposed as user, usage, architectural design, social context, and physical environment (Figure 2.3).

There is an interaction between visual and soundscape perception that when we perceive visual information in the space it will modify the perception of the soundscape at the same time (Offenhuber and Auinger 2013, McGurk and MacDonald 1976). Besides, the biological side of people does also influence the way they respond to certain aspects of soundscape (Lindborg 2013), other aspects are managed through the cognitive, personal ways, yet probably determined by the user’s character (Lindborg 2015). It has been stated by Fortkamp and Fiebig (2016) that the perception of an acoustic environment depends on the auditory attention which leads us to understand how the sound receivers perceive their soundscape. This implies that the subjective perception of sound depends on several auditory aspects such as sound sources, the acoustic environment, and auditory attention (Pascual et al. 2016)

Figure 2.2: Factors of soundscape perception model



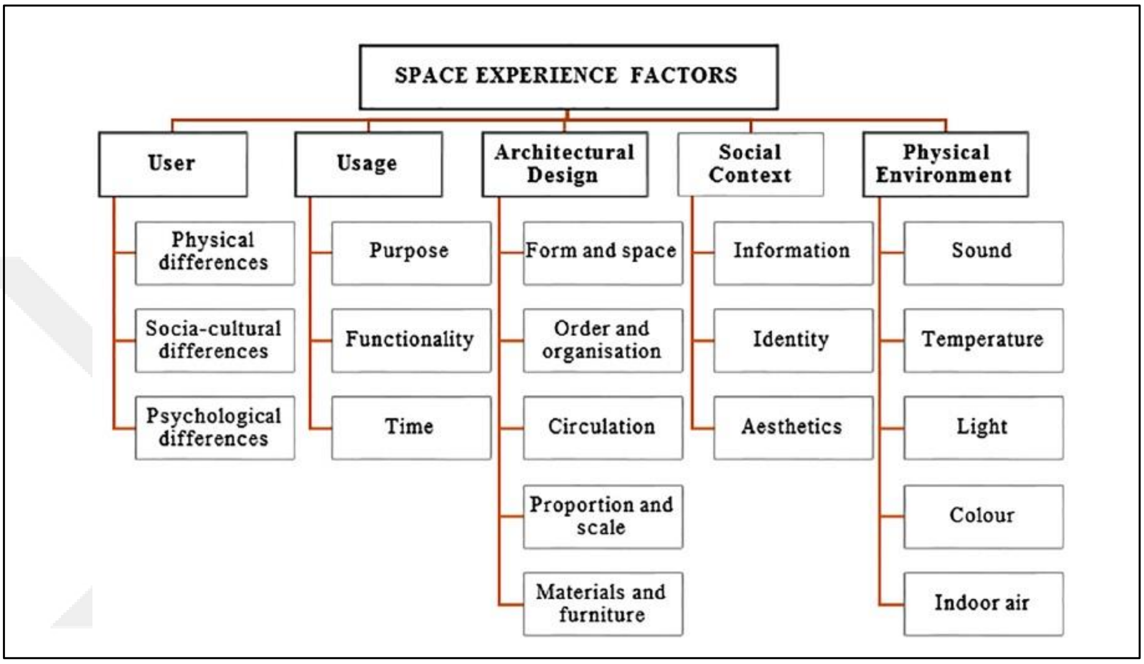
Source: Dokmeci and Aburawis (2018a)

A number of researchers have investigated the elements affecting soundscape perception through several methods and have reported that perception tend to be influenced by human behaviour and activities within the evaluated space (Jeon and Hong 2015, Davies et al. 2013). Another study carried out under this context (Martinez et al. 2018) has revealed that the dominant sound sources of an acoustical environment does affect the perceived soundscape and its quality. In addition, a recent study by Xiao and Hilton (2019) have found that the demographic factors of individuals play a significant role on the sound perception. This implies that the subjective perception of sound depends on several aspects such as sound sources and the acoustic environment, auditory attention, reactions and outcomes (Pascual et al. 2016).

2.2.2. Space experience

Various researches have been done in the sonic environment field related the perception of sound to the user's experience of space. Gathering the information of space is applied through five channels (vision, hearing, smell, tactility, and taste senses), which controls the observation of space (Dokmeci and Kang 2016). Soundscape represents the acoustic environment and it concentrates on the auditor's experience in a specific space (Hedfors 2003). There are many factors that are effective in the determination of the sense of space. The users meet this sense by getting through physical contact with the medium they occupy. Moreover, the experience of space through the sense of vision is different than hearing. Spatial awareness occurs by means of all senses (Aburawis and Dokmeci 2018). However, the mixture of vision and hearing senses within a space impacts the space experience and perception of soundscape (Gozalo et al. 2015, Solomon 2012, Yang and Kang 2005b).

Figure 2.3: Factors of soundscape perception



Source: Dokmeci and Aburawis (2018a)

Exploring a space with open eyes enables individuals to be aware of the distance between them and the visualised object, in contrast, the sense of hearing with its multidirectional characteristic covers all the 360 degrees of the perceived space. Pascual et al. 2010 have designed a theoretical model to explain the environmental experience and its effects on the soundscape perception. It has been found that the act of being in a specific space stimulate various psychological and physiological reactions which permit the space user to collect information and impressions about it (Pascual et al. 2010). In addition, the experience of space is attained over the combination of diverse social and psychological aspects such as expectation, pleasantness, space identity, familiarity, and information (Pascual et al. 2010). In addition to these factors, a list of several other aspects affecting the space experience has been presented in the literature such as social characteristics (gender, age, education level, experience…), design features (plan and design, colour, materials…), and environmental conditions (temperature, sound, light…) (Hidayetoğlu et al. 2010, Baker 1986).

Blesser and Salter (2006) have presented the term ‘aural architecture in their book, which refers experiencing the space features through the act of listening. In light of an earlier study, it has been found that elements defining the sound environment are also influencing the user’s experience within a space (Adams et al. 2009). Furthermore, any transitions that occur in a space influence the soundscape in consequence, which highlight the crucial interaction existing between the soundscape perception and space experience. These changes are to be estimated by studying the individual’s experience in the indoor space.

2.3. METHODS FOR EVALUATING SOUNDSCAPE

Much of the current literature on acoustics pays particular attention to the soundscape study. Many examples of techniques to assess a soundscape were studied and discussed. A soundscape evaluation requires several elements to be taken into account. Thus, it is important to consider the contribution of sound, user, space, and the physical conditions during the soundscape assessment.

2.3.1. Outdoor soundscape evaluation

The methods of sound evaluation vary from the indoor to outdoor acoustic environment. Several researchers investigating the urban soundscape tend to follow different evaluation techniques than the ones used for an indoor soundscape. A number of studies have examined the urban sonic environment through soundwalks (Bahali and Bayazit 2017, Kang and Zhang 2010, Semidor 2006, Davies et al. 2003). Soundwalk studies have been popular in the field of urban soundscaping for their use in redesigning a better outdoor soundscape for the built environment. The process of data gathering through soundwalks provides several information regarding the urban features and the sound environment connection, which allows the researchers to identify the pleasant and preferred sounds within the evaluated outdoor environment. Furthermore, in a recent study, Steele et al. (2016) combined three different methods in a study executed for analysing the soundscape of an urban park in Montreal, where behavioural mapping, questionnaires, and sound recordings methods were applied. Liu and Kang (2016) have followed a different method to evaluate the outdoor soundscape. They have conducted a study based on the psychological understanding of individuals within the urban soundscape. Therefore, a grounded theory approach has been applied in order to reveal the factors affecting users' preferences (Liu and Kang 2016).

The semantic differential approach is another method used by investigators for the assessment of outdoor environments. This technique was first introduced by Osgood et al. (1957) aiming at discovering the major factors that shape the urban soundscape. Numerous studies evaluating the outdoor sound environment in public spaces have followed this approach in order to determine the affecting factors of the urban soundscape (Boya et al. 2016, Song et al. 2012, Kang and Zhang 2010, Ge and Kazunori 2004, Zeitler and Hellbrück 2001).

The evaluation of an urban soundscape is a complex process that requires the use of several methods. A study by Abo Eleinen et al. (2016) have conducted an interview and questionnaire method in their assessment process. As presented in figure 2.4, the researchers (2016) revealed in their article a set of different soundscape evaluation techniques that have been used for the urban environments. Recent studies in this filed have been developing new methods to assess the urban soundscape. A study by Ou et al. (2017) have adopted the service quality measurement model that is normally used in the business and industry. This method was based on evaluating the importance and satisfaction given to the quality of the sound environment, which allow researchers to attain precise findings regarding the soundscape quality (Ou et al. 2017).

Figure 2.4: Methods to assess the soundscapes of urban outdoor spaces

	Assessing soundscape in situ	Assessing soundscape in the laboratory
Definition	The person listens to the soundscape in the actual location	The person who is assessing the soundscape stays in a room or laboratory listening to a previously recorded soundscape
Methods	▪ Soundwalks ▪ Interviews ▪ Scales: semantic and Likert ▪ Categorical responses ▪ Acoustical diary ▪ Acoustical measures ▪ Mixed methods	▪ Scales: semantic and Likert ▪ Artificial Neural Network ▪ Mixed methods
Advantages	Assessing a soundscape in situ provides results which show the complexities of real world situations that depend on environmental, physical, psychological, and socio-cultural information, but it is difficult to ascertain the specific role of individual elements in the assessment.	Assessing soundscape in the laboratory provides control of which specific elements should be considered to ascertain those that have serious affects in soundscape assessment and show the relationships between experimental variables.

Source : Abo Eleinen et al. (2016)

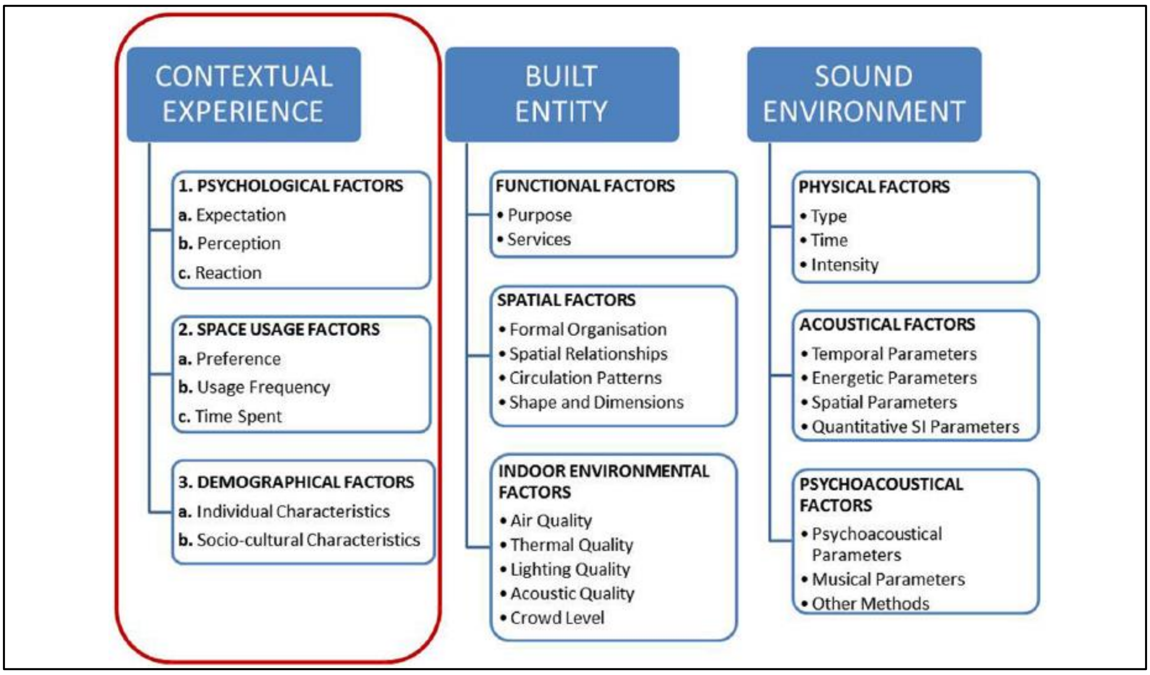
2.3.2. Indoor soundscape evaluation

The literature has presented various soundscape evaluation methods which differ from each other depending on the objective of the study (Aletta et al. 2016). Indoor soundscaping is a combination of the earlier theories and methods applied in the field of acoustics as it presents new insights regarding the acoustical evaluation in enclosed spaces (Dokmeci and Kang 2016). Several studies (Aletta et al. 2017, Dokmeci and Kang 2016, 2011, Zhang et al. 2016) have followed an objective analysis which rely on sound recordings method to analyse the measurements of acoustical and psychoacoustical factors that allows the understanding of user’s impression of the sound environment. The soundwalk method have been mostly used to evaluate urban public spaces, however a study by Dokmeci and Kang (2012a) have followed this method in order to analyse the indoor public and commercial areas. Analysing the architectural characteristics and usage of the enclosed environment is notably important, in addition to the evaluation of loudness, sound pressure level and other psychoacoustic and acoustic parameters (Dokmeci and Kang 2012a).

Previous studies analysing the soundscape have focused on objective assessment results to defend the subjective analysis that focus on the user’s perception, yet, improved evaluation methods regarding the indoor soundscape approach started to take place in the recent literature (Dokmeci and Kang 2017). The grounded theory is one of the qualitative approaches followed to assess the indoor sound environment by focusing on the space users. This method has been followed by many researchers to analyse the subjective perception of individuals towards the indoor soundscape (Acun and Yilmazer 2018a, Fiebig and Fortkamp 2004). Recent studies by Aburawis and Dokmeci (2018b) have developed a new analysing method for the indoor soundscape by following a post occupancy evaluation method. The post occupancy evaluation was used to identify the relationship between sound and space, through a process which consists of three phases, indicative, investigative, and diagnostic stage Aburawis and Dokmeci (2018b).

Moreover, the questionnaire method has been frequently used in the process of indoor soundscape analysis. The acousticians Dokmeci and Kang (2017) suggest that following a questionnaire method for the subjective evaluation of enclosed spaces is the key to analyse the indoor sound environment. Based on a series of researches they (2017) have designed an indoor soundscape questionnaire for the purpose of evaluating the indoor public sound in an enclosed library environment. This study has followed a specially designed questionnaire for evaluating an indoor space through investigating the effects of each of the contextual experience factors on each other (Dokmeci and Kang 2017).

Figure 2.5: Variables of the indoor soundscape framework



Source: Dokmeci and Kang (2017)

The writers established an indoor soundscaping framework that include three aspects to follow in the indoor soundscape evaluation (Figure 2.5). With a focus on the contextual experience variable, their study has concentrated on the interaction between students and their library environment, therefore the three aspects examined during the questionnaire survey were demographical, psychological, and space usage factors. Overall in their study the writers (2017) have presented different types of questions to test the indoor environment in terms of architectural factors, acoustical features, and physical indoor environment conditions. Users' assessments of quality and importance regarding the questions asked have presented significant understandings about the reaction and expectation aspects (Dokmeci and Kang 2017). On the other hand, the assessment of several sound sources defined by the authors (Dokmeci and Kang 2017) through ratings of annoyance and preference/disturbance has provided important insight regarding the perception and reaction to the sound environment.

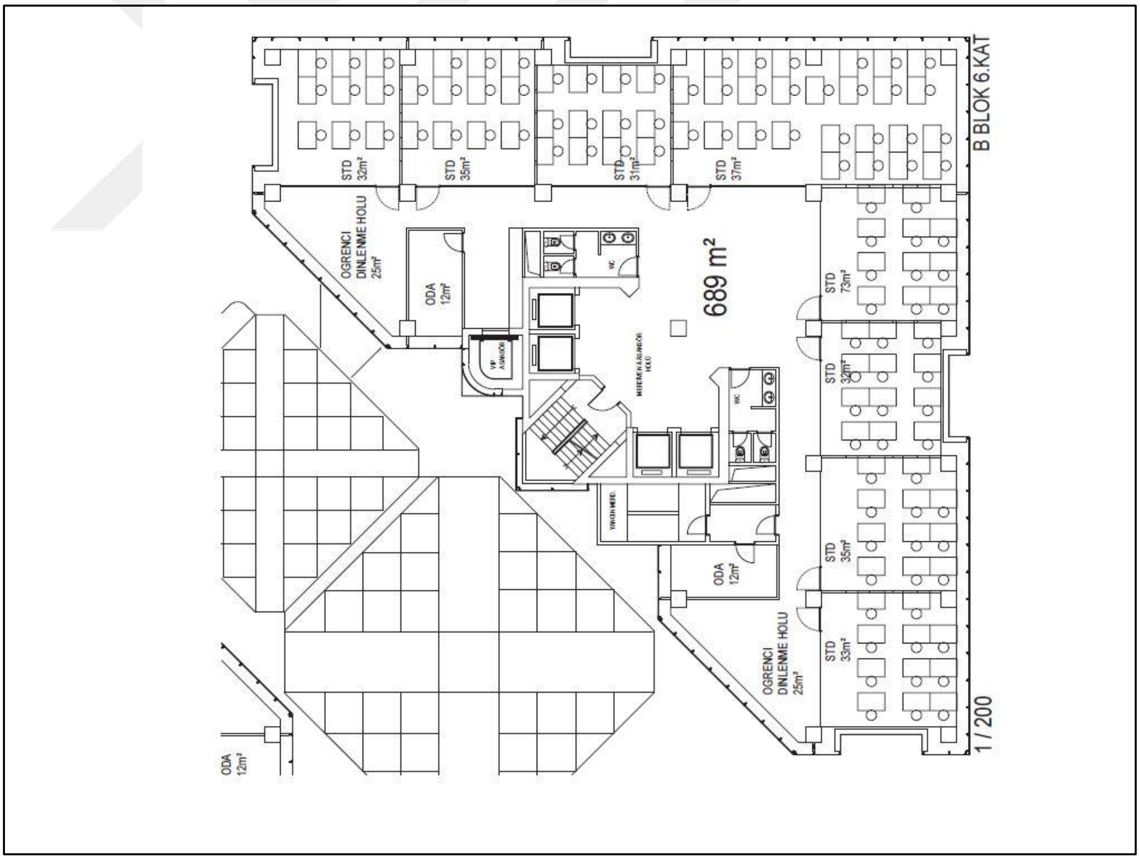
3. METHODOLOGY

In order to achieve the aim of this thesis a research methodology was adopted. It is highly notable to choose the appropriate methodology for a study as it has a matter of great importance in the research process and in drawing the attention to the requirements of the study and the statement of the thesis. Several ways to collect data and gather information are available. Correspondingly, A quantitative research focuses on gathering numerical data and generalizing it across groups of people or to explain a particular phenomenon (Babbie, Earl R., 2010). Therefore, a quantitative approach was employed in this research to highlight the statistical analysis of the collected data over a questionnaire. One of the aims of this work is to explore the sound environment of the indoor soundscape of the architecture studio classrooms based on the students experience of the space. In order to fulfil this objective, a questionnaire method has been followed. There are many studies who aimed to analyse enclosed sonic environments through an objective assessment. These studies take sonic measurements and objective factors as a basis to analyse the users' perception of their indoor soundscape. The investigation method in this study has followed a subjective aspect to examine the possible connections between sound perception and space experience variables. The evaluation process goes through three steps. Initially the identification of the enclosed environment to be studied is required then the selected case study space is observed. In addition, the research sample is defined by limiting the category of participants according to their educational level, which provides a variation of opinions. Secondly, an indoor soundscape questionnaire is designed in accordance with the chosen space features and conditions. The questions included in the form are all based on an adapted framework designed for this thesis and the space experience factors and sound sources perception are rated accordingly by the users. After gathering the data of the applied questionnaire, the last step is the statistical analysis and evaluation of the results found from the survey, by using the relevant tests that are convenient to the nature of the study.

3.1. CASE STUDY SELECTION

The daily use of the personal or shared spaces by human beings consist an interactive relation between the users and space. the term soundscape is an individual's, or society's, perception and understanding of the acoustic environment (Yang and Kang 2005, Porteous and Mastin 1985). Therefore, a soundscape exists through human perception—but always within the context of a particular time, place, and activity (Brown 2012). Studies concentrating on the different measurement and analyses methods of the sound environment and human perception are mostly related to the urban scale (Truax and Barrett 2011, Kang 2006). However, the investigations in this research were appointed toward the indoor soundscape**.** Within the framework of this thesis, a case study approach was used to limit the study's range of research to the architecture studio classrooms located in Bahçeşehir University. The indoor soundscape questionnaire surveys were carried out in the Faculty of Architecture and Design campus.

Figure 3.1: 6th floor plan of the Architectural studio classroom of Bahçeşehir University, North campus



The architectural characteristic of the classrooms designated for the architecture studio courses are almost the same. The classrooms are large in size with an L shape form (Figure 3.1). On each floor a studio is located with many different entrances. In addition, each studio is supplied by a set of flexible partition walls that are used to define different spaces within the studio, in order to provide privacy for smaller group works and discussions. On the other hand, the questionnaire participants were chosen to be from the department of Architecture. A group of 140 Freshman students and 120 Senior students of mixed female and male genders were asked to participate in this survey. The research was conducted at two separate architecture studio classrooms that are usually assigned for each of the two groups of participants. In addition, the students were asked to answer the questionnaire during the class time in order to evaluate the perception and experience concepts accordingly.

3.2. QUESTIONNAIRE

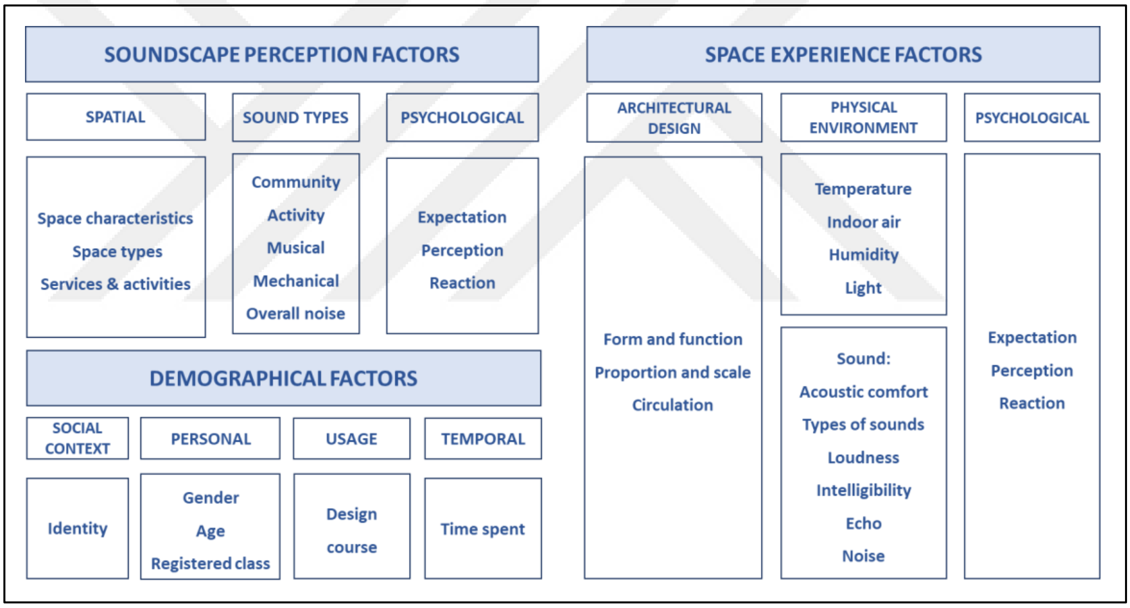
3.2.1. Questionnaire design

Under the frame of this research, an indoor soundscape questionnaire was designed to evaluate the existing relation between the user's space experience and their perception of the acoustic environment. The questionnaire method was applied as it was maintained suitable for this thesis research since the purpose of this study was to investigate the soundscape perception of individuals. A survey affords effectual methods of collecting information with regards to the respondents' perception. Likewise, the questionnaire method is regularly used to collect data and information regarding attitudes and behaviour. Further, the users are the key factors for any soundscape study, so understanding their characteristics, behaviour patterns and psychology is crucial for the indoor soundscaping research as well (Dokmeci and Kang 2017). In line with the research main topics outlined in the previous paragraphs, this section aimed at designing an indoor soundscape questionnaire as a statistical tool for data gathering.

Besides, the structure of the questions asked in the questionnaire designed for this study was based on the model used by Dokmeci and Kang (2017). Their article was relying on an Indoor Soundscape Questionnaire that is established over the contextual experience variable of indoor soundscape evaluation, in an enclosed library foyer environment. Their study (2017) aimed to define the effects of space usage and demographical factors on psychological factors through the indoor soundscape evaluation. In addition, in order to identify the affecting aspects to be evaluated in this study, the set of the factors defined under soundscape perception and space experience concepts presented by Aburawis and Dokmeci (2018a) were taken into consideration.

In this thesis, psychological factors which are Expectation, Perception and Reaction, are evaluated regarding the user's demographical factors in order to understand the perception of the occupants interacting with their indoor space. Furthermore, an adapted framework was considered, and the space factors and sound sources of the case studios were presented as shown in Figure 3.2. The indoor soundscape questionnaire in this study was designed based on this adapted framework, in order to evaluate the soundscape of the architecture studio classrooms and how the students perceive it.

Figure 3.2: The adapted framework of the soundscape perception, space experience, and demographical factors used in this study

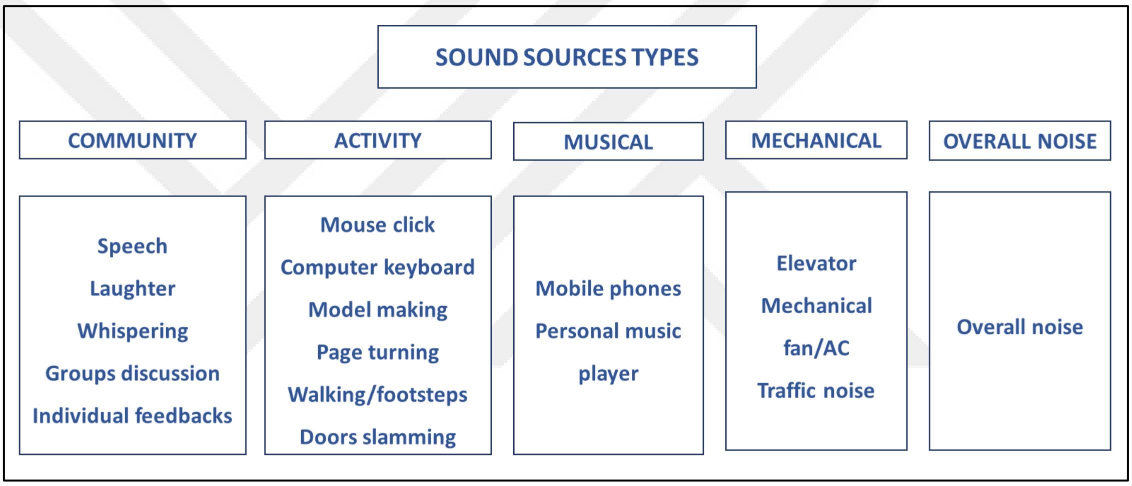


In the case of this thesis, the structure of the questionnaire was designed for the purpose of evaluating the perception and experience notions in the architecture studio classrooms used by Freshman and Senior students. The questionnaire was divided to three different parts:

a. Demographical information
b. Space experience
c. Soundscape perception

The first part included general individual information about the users such as gender, age, education level, and time spent (Table 3.1). The second part as presented in Table 3.2 and Table 3.3, was dedicated for evaluating the space experience factors (architectural design, physical environment, and sound) regarding importance and quality rates. While the last part (Table 3.4 and Table 3.5) comprised questions about the user's perception to sound sources regarding annoyance and preference rates, in order evaluate the soundscape perception. Sound sources of the chosen case studios are summarised in the Figure 3.3 below.

Figure 3.3: Sound source types evaluated within the designed indoor soundscape



In addition, in order to collect information from the users the close-ended survey question type was used, with the aim of providing a set of predefined questions. The participants were given a list of predetermined responses from which to choose their answers. The questionnaire was constructed using the Likert scale that enables the respondents to rate their degree of agreement as an answer to the posed question.

The students were asked to answer the selected questions of each table by rating the variables of importance and quality of their architectural studio classrooms followed by the variables of annoyance and preference of their soundscape. Moreover, an open-ended question was added to Table 3.4 and 3.5 asking the students to propose any other sound sources that they think they may be annoying or preferred in their acoustical environment.

The aim of the latter questions is to obtain enough information about the evaluated soundscape from the point of view and expectations of the space users.

Table 3.1: Demographical information

- Please fill in this part according to your profile.

Demographical information			
1	Gender	☐ Male	☐ Female
2	Age		
3	Educational level	☐ Freshman (1st grade)	☐ Senior (4th grade)
4	Registered class	☐ Arc 1002	☐ Arc 4001
			☐ Arc 4002
5	Time you spend in the architectural studio for the Design course during the week		

Table 3.2: Factors rated according to the importance level to evaluate Space Experience

- Please rate the factors given below according to how important you think they are in evaluating the Space Experience in an architectural studio.

Factors		**Ratings on importance**				
		Rate from (1) not important to (5) very important				
1	Level of indoor air quality	1	2	3	4	5
2	Level of indoor humidity	1	2	3	4	5

3	Level of thermal comfort	1	2	3	4	5
4	Brightness of lighting	1	2	3	4	5
5	Level of sounds (loudness)	1	2	3	4	5
6	Level of acoustic comfort	1	2	3	4	5
7	Different types of sounds	1	2	3	4	5
8	Intelligibility of sounds (definition)	1	2	3	4	5
9	Level of reverberation (echo)	1	2	3	4	5
10	Ability to locate via sounds	1	2	3	4	5
11	Way-finding (ability to find your way around)	1	2	3	4	5
12	Level of crowd (users' density in the space)	1	2	3	4	5
13	Level of spaciousness	1	2	3	4	5
14	Noise from neighbouring spaces	1	2	3	4	5
15	Architecture studio planning in terms of human scale	1	2	3	4	5
16	Form and function relationship	1	2	3	4	5

Table 3.3: Factors rated according to the quality level to evaluate Space Experience

- Please rate the factors given below according to their quality in your architectural studio

Factors		**Ratings on quality**				
1	Level of indoor air quality	Rate from (1) very bad to (5) very good				
		1	2	3	4	5

2	Level of indoor humidity	Rate from (1) very good to (5) very humid				
		1	2	3	4	5
3	Level of thermal comfort	Rate from (1) very uncomfortable to (5) very comfortable				
		1	2	3	4	5
4	Brightness of lighting	Rate from (1) very dull to (5) very bright				
		1	2	3	4	5
5	Level of sounds (loudness)	Rate from (1) very loud to (5) very quiet				
		1	2	3	4	5
6	Level of acoustic comfort	Rate from (1) very uncomfortable to (5) very comfortable				
		1	2	3	4	5
7	Different types of sounds	Rate from (1) very similar to (5) very diverse				
		1	2	3	4	5
8	Intelligibility of sounds (definition)	Rate from (1) very blurred to (5) very defined				
		1	2	3	4	5
9	Level of reverberation (echo)	Rate from (1) very echoey to (5) very absorbed				
		1	2	3	4	5
10	Ability to locate via sounds	Rate from (1) very hard to (5) very easy				
		1	2	3	4	5
11	Way-finding (ability to find your way around)	Rate from (1) very hard to (5) very easy				
		1	2	3	4	5
12	Level of crowd (users' density in the space)	Rate from (1) very crowded to (5) very empty				
		1	2	3	4	5
13	Level of spaciousness	Rate from (1) very spacious to (5) very enclosed				
		1	2	3	4	5
14	Noise from neighbouring spaces	Rate from (1) very audible to (5) very inaudible				
		1	2	3	4	5

15	Architecture studio planning in terms of human scale	Rate from (1) very irrational to (5) very rational				
		1	2	3	4	5
16	Form and function relationship	Rate from (1) very incoherent to (5) very related				
		1	2	3	4	5

Table 3.4: Sound sources rated according to the annoyance level to evaluate Soundscape Perception

- Please rate the factors given below according to how annoying you think they are to be in your architectural studio

Sound sources		**Rate from (1) not at all annoying to (5) extremely annoying**				
1	Speech	1	2	3	4	5
2	Laughter	1	2	3	4	5
3	Whispering	1	2	3	4	5
4	Groups discussion	1	2	3	4	5
5	Individual feedbacks	1	2	3	4	5
6	Mouse click	1	2	3	4	5
7	Computer keyboard	1	2	3	4	5
8	Model making	1	2	3	4	5
9	Page turning	1	2	3	4	5
10	Walking/footsteps	1	2	3	4	5
11	Doors slamming	1	2	3	4	5
12	Mobile phones	1	2	3	4	5
13	Personal music player	1	2	3	4	5
14	Elevator	1	2	3	4	5
15	Mechanical fan/AC	1	2	3	4	5
16	Traffic noise	1	2	3	4	5
17	Overall noise	1	2	3	4	5

18	Cite other **annoying** sound sources

Table 3.5: Sound sources rated according to the preference level to evaluate Soundscape Perception

- Please rate the factors given below according to how preferable they are to be in your architectural studio

Sound sources		**Rate from (1) very disturbing to (5) very preferable**				
1	Speech	1	2	3	4	5
2	Laughter	1	2	3	4	5
3	Whispering	1	2	3	4	5
4	Groups discussion	1	2	3	4	5
5	Individual feedbacks	1	2	3	4	5
6	Mouse click	1	2	3	4	5
7	Computer keyboard	1	2	3	4	5
8	Model making	1	2	3	4	5
9	Page turning	1	2	3	4	5
10	Walking/footsteps	1	2	3	4	5
11	Doors slamming	1	2	3	4	5
12	Mobile phones	1	2	3	4	5
13	Personal music player	1	2	3	4	5
14	Elevator	1	2	3	4	5
15	Mechanical fan/AC	1	2	3	4	5
16	Traffic noise	1	2	3	4	5
17	Overall noise	1	2	3	4	5
18	Cite other **preferable** sound sources					

3.2.2. Execution

After designing the questionnaire form that will be adopted in this study, the survey method is applied, and the selected groups of students are asked to fill in personally the delivered questionnaire forms. The survey is held in the architectural studio classrooms during the course time, and the students get their time to answer the questions accordingly. The architecture studio course for Freshmen students is held once a week into two sections between 8:30 to 12:30 and from 13:30 to 17:30. However, the Senior students have their course two times a week between the hours 13:30 to 17:30. On the other hand, the data collected from the questionnaire survey will be analysed statistically. The findings of this survey will be discussed to draw a conclusion about the evaluation of the indoor soundscape perception through the space experience.

3.3. EVALUATION

The Indoor soundscape questionnaire designed for this research will allow us to compare the findings of this case study to the previous researches. The data gathered form the survey is analysed by a statistical software that provides significant findings between the presented factors and sources. There are several statistical tests used for the evaluation of such a subject. The software includes different categories of data analysis such as Reliability analysis. Cronbach's alpha coefficient is the determinant element of a reliable questionnaire. Thus, a questionnaire is defined as reliable when the Cronbach's α value of a question group is higher than 0.70. In addition, in order to decide whether a parametric or non-parametric test should be used for the case study, Homogeneity and Normal Distribution analysis must take part in the examination. The compulsory element that allows the use of a parametric test (such as T-test, Pearson's correlation, one-way ANOVA test), is an asymptotic significance value that is >0.05. If one of these two tests do not meet the requirements, then a type of non-parametric tests must be used, such as Spearman correlation, Mann-Whitney U test, Chi square test... These sorts of analysis assist in the determination of the convenient correlation statistical tests for the case study in order to find relevant relations between the tested variables. Moreover, it is helpful to determine the types of the data that is being measured (dependent or independent) as well as the level of measurement of the variables (ordinal, nominal, scale…), to be able to apply the appropriate statistical method to get relevant results to analyse.

4. IMPLEMENTATION

4.1. THE SELECTED ARCHITECTURAL STUDIO AND PARTICIPANTS

The Faculty of Architecture and Design of Bahçeşehir University was chosen to be the case study for this research. The campus is located in a mixed-use area where the surroundings differ from residential use to commercial use facilities. The B block where the faculty is located in, is a nine-storey building which 4 floors of it are assigned for architecture studios. The area that the architecture studios occupy on each floor is 308 m^2 out of 689 m^2 of the total floor's area. The distribution of the studios on each level has followed an L shape form, which creates a small hall that separates the core and elevator area from the floor's entrance to provide a sense of privacy. Moreover, the moveable partition walls placed in each studio are dividing the space to many different classrooms with different surfaces. These moveable partition walls were placed in order to create smaller studio areas according to the number of students taking the course, and also minimize the indoor sound sources coming from the indoor environment. During seniors' course hours, groups of about 30 students each are separated according to their advisors. The moveable partition walls are kept closed, and each of the created spaces are occupied by at least two different groups of students. On the other hand, freshman students are more likely to have an interactive design course, therefore, they tend to keep the partition walls open to create a large open space for interaction. The area of each classroom varies between 32 m^2 to 74 m^2 which creates five to eight separated studios. A student's rest zone with a 25 m^2 area is situated on the two corners of the corridor of each floor. In addition, each studio is provided by many fan coil units for HVAC system, which consist of a ventilation fan and a heating/cooling exchanger. Moreover, the building is enveloped by large glass windows from all directions. Although the campus is located in a secluded area, most of the openings are facing the main roads, which makes the architectural studios receive different outdoor sound sources. On the other hand, students chosen to participate in this study were limited to the department of Architecture only. The space users who took place in this survey were from two different educational levels. Around 120 students are registered in the 4th grade, and 140 students are registered in the 1st grade. The questionnaire was addressed to the Freshman and Senior students only. The survey has taken place at the 4th and 6th floor architectural studios for ARC 1002 which is the course name for the 1st grades. While for the 4th grades, ARC 4001 and ARC 4002 they all take place on the 6th floor. The architecture studio users were asked to participate in this survey during the course hours and the questionnaire was delivered to them according to their course schedule.

4.2. EXECUTION OF THE QUESTIONNAIRE

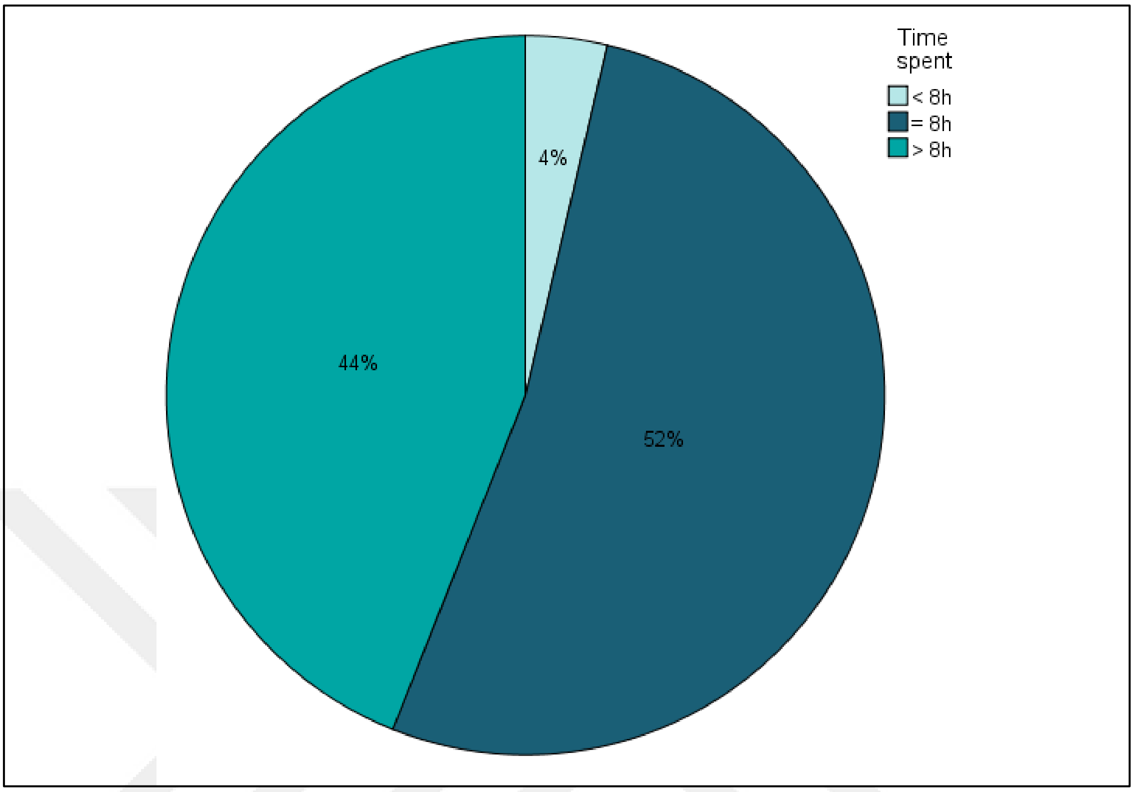
The questionnaire survey was held on three different days of the same week in order to reach the three different student groups who participated in the indoor soundscape questionnaire. The architecture studio course for Freshmen students is held once a week on two sections, morning and afternoon. However, the Senior students have their course two times a week on the afternoon hours. The questionnaire was distributed to Senior students on two different course days according to their schedule, while for Freshman students it was handed out within a single day. The selected groups of students were gathered, and the thesis subject was explained to each group apart, in order to be aware of the nature of the study. They were asked to answer the delivered questionnaire forms during the course time according to their personal perception and experience. The total number of the participants in this survey is 191 students out of 260 registered students. Among these participants 107 of them are 1st grade students and 84 are 4th grade students. The 4th grades are divided to two levels, 14 of them were registered in ARC 4001, and 70 were in ARC 4002. A consent form was attached to the questionnaire form to inform the students briefly about the thesis subject and to get their agreement on being part of this study. Most of the Senior students refused to participate in the survey which made the number of samples to analyse less than what was expected. Although the estimated time to answer the questionnaire was from 5 to 10 minutes, the survey was done in almost 4 hours for the 4th grades. In contrast the duration of the survey for the 1st grades ranged from 2 to 3 hours in duration. Along with that, the questionnaire form contained three different parts. The first one included questions about demographical information such as gender, age, educational level, and time spent. The second part comprised 16 different factors of the space experience variable that goes under architectural design (from and space, circulation, proportion and scale) and physical environment (sound, light, indoor air). These factors were rated by the space users first according to their importance in an architectural studio, then according to their quality in the faculty's architectural studios. The last part included 17 different sound sources of the studio's soundscape. These sources were evaluated by two methods, the first one is by rating the range of annoyance of the sound, while the second method is by defining whether the sound is disturbing or preferable according to the user's perception.

The collected data from this survey was later coded and transferred to the convenient statistical computer program to be analysed correspondingly. Afterwards the themes and patterns derived from the statistical tests were analysed in accordance to the perception and experience concepts.

4.3. RESULTS OF THE QUESTIONNAIRE

The questionnaire applied in this research aimed to evaluate the concepts of perception and experience of an indoor environment under the case study of Bahçeşehir University's architecture studio. By the end of this nonexperimental investigation, information was gathered from a sample of 191 students. The survey was addressed to 111 females and 80 males. The participants are divided into two different education levels. A number of 107 respondents from the 1st grade, and 84 from the 4th grade have answered the questionnaire form. A question concerning the Time spent in the architecture studio for the Design course during the week was asked. As shown in Figure 4.1, the results demonstrate that a group of 52% of the users spend 8 hours in total in their studio which is the official duration of the Design course. The other 44% of the users spend a duration of time up to 50 hours per week. These respondents frequently spend more time preparing for their design course in the studio. While only 4% of the students spend less than 8 hours in their classroom. This group of users prefer not to attend the regular time of the course, and they are more likely to leave after getting their project progress feedback.

Figure 4.1: Time spent percentages defined by three categories: <8h, =8h, >8h



Within the frame of this study 16 questions related to the space experience were categorized as architectural design and physical environment factors. Respondents were asked to evaluate these variables according to their importance and quality. Averages of the responses revealed that the Level of indoor air quality and the Brightness of lighting factors were rated as very important in an architecture studio environment. While the factors defined as Different types of sound and Level of reverberation (echo) were rated as the least important ones (Figure 4.2). Additionally, Way finding and Brightness of lighting of the selected studios in this study were found to have the highest quality ratings, whereas the Level of indoor air quality and Acoustic comfort factors had the lowest ones (Figure 4.3).

Figure 4.2: Averages of the Space Experience factors rated according to their importance

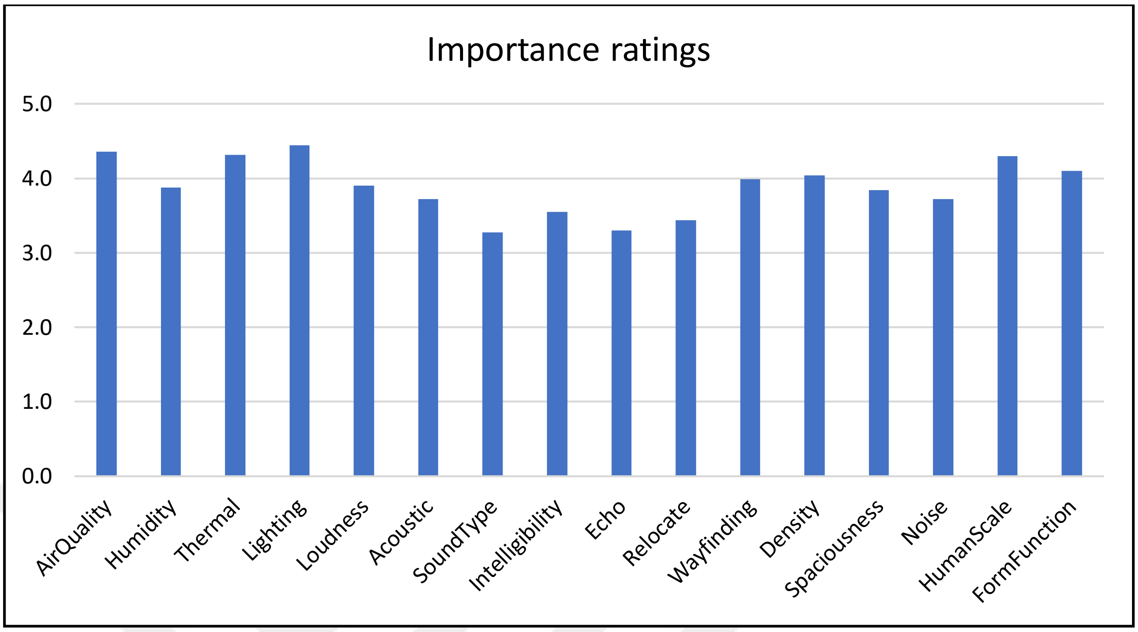
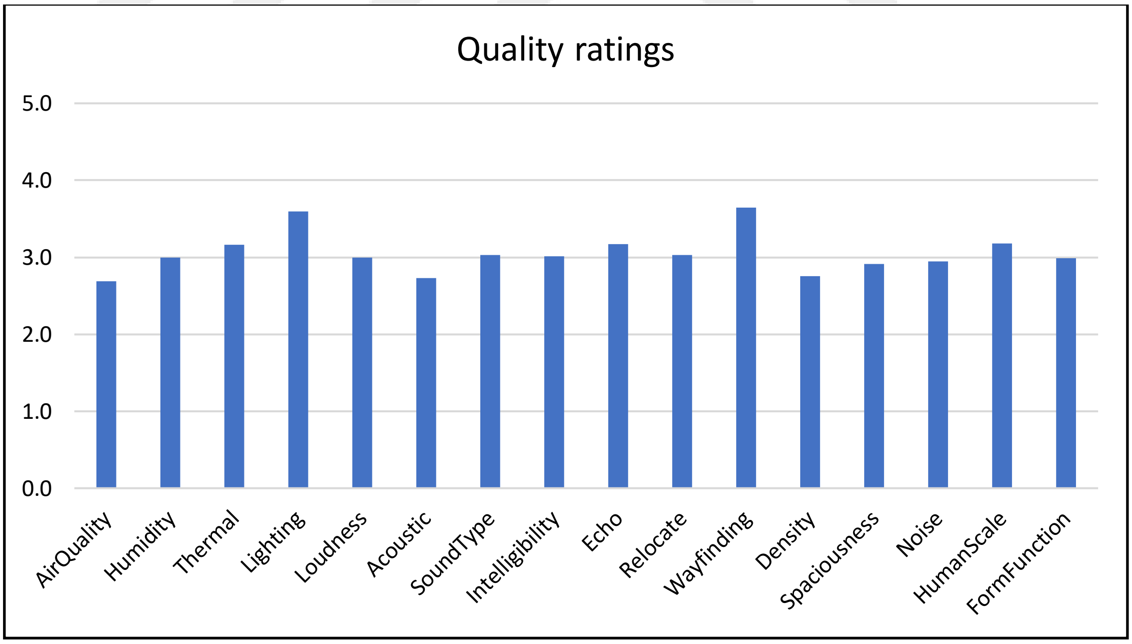


Figure 4.3: Averages of the Space Experience factors rated according to their quality



On the other hand, a list of 17 sound sources (community sounds, activity sounds, musical sounds, mechanical sounds and overall noise) that define the soundscape of the architecture studio were rated by the users according to their perception of annoyance and preference/disturbance. The sound of Laughter was selected as the most annoying source while the sound of Page turning was rated as not at all annoying (Figure 4.4). The averages of the sound sources regarding the preference/disturbance scale where 0 refers to ‘disturbance’ and 5 refers to ‘preference’ are presented in Figure 4.5. The factors identified were Individual feedback which was perceived as a preferable source within the architecture studio’s soundscape, and Doors slamming sound that was evaluated as the most disturbing sound.

The data gathered by the designed indoor soundscape questionnaire was analysed statistically using the SPSS 20. Software. The main variables that are statistically examined in this study are divided into two different groups. Demographical factors that are gender, education level, and time spent are defined as independent variables. While space experience and sound perception factors were identified as dependent variables.

Figure 4.4: Averages of the Soundscape Perception sources according to Annoyance ratings

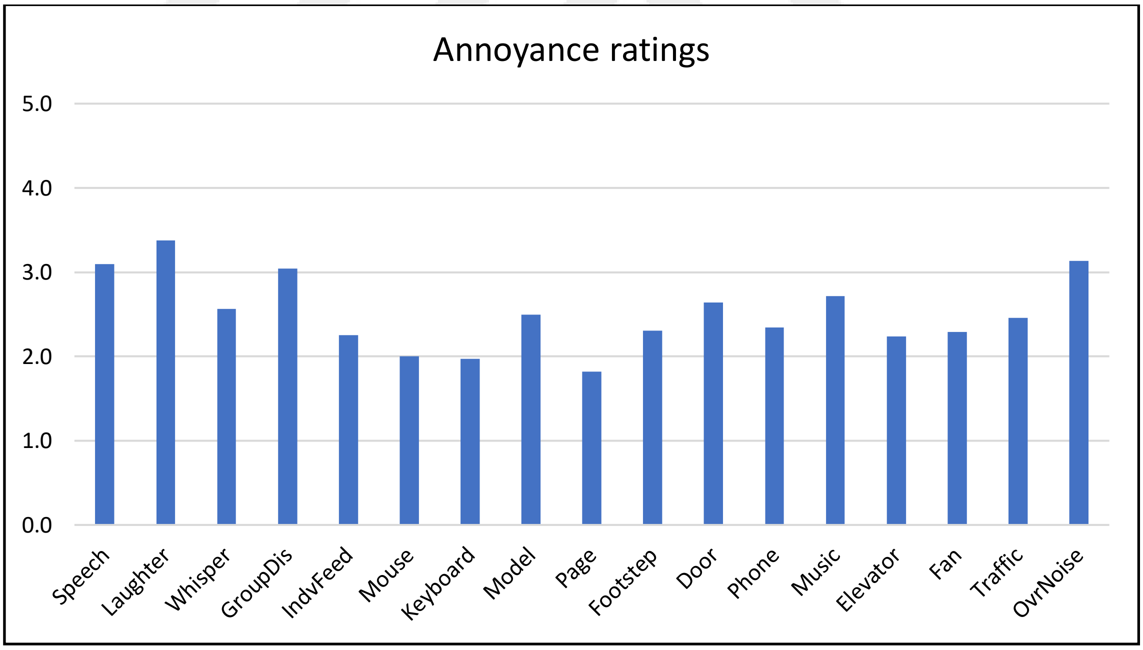
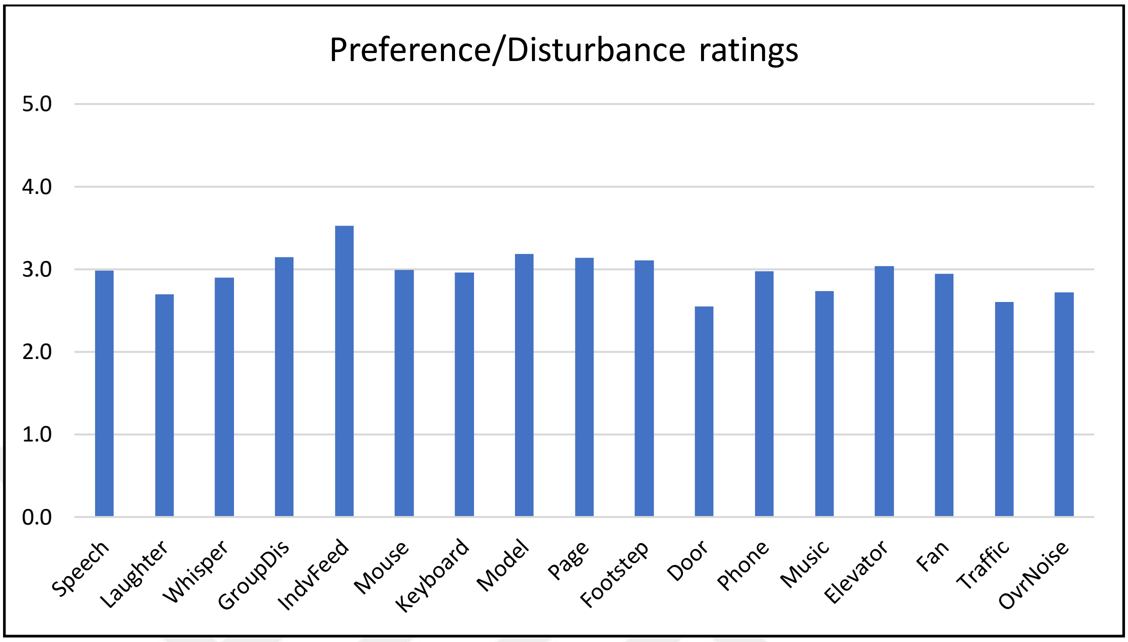


Figure 4.5: Averages of the Soundscape Perception sources according to Preference/ Disturbance ratings



Furthermore, a reliability analysis was conducted in this study for all the question groups. The reliability statistics for the space experience factors rated by importance (Table 3.2) shows a Cronbach's α value of 0.863. Similarly, quality ratings (Table 3.3) Cronbach's α value is 0.820, for sound sources annoyance (Table 3.4) it is 0.848 and for sound sources preference/disturbance (Table 3.5) the value is 0.870. Since that all the groups of questions were found to have a Cronbach's α value higher than 0.70, the questionnaire is considered to be reliable. In addition, two more statistical tests were applied to assess in the determination of the correlation test to be used to analyse the relationships between the different variables investigated in this survey. Homogeneity test revealed that the questionnaire data is homogenous as the Asymp. Sig. (asymptotic significance) value is >0.05. While for Normal Distribution analysis the Asymp. Sig. value is less than 0.05, which indicates that the data is not normally distributed, therefore it implies the use of non-parametric tests for the data at hand. With this in mind, evaluations were made to understand the substantial relations among nominal demographical variables (Gender and Education level) and the ordinal variables presented in the questionnaire using the Non-parametric Mann-Whitney U test. Under the same context, another investigation is done using Kruskal Wallis test to recognise the statistical significance between the categorical variable (Time spent) and the ordinal variables of the case. These two statistic tests highlight the considerable connections between the examined factors; however, they don’t provide any data regarding the relationship strength. Therefore, the selected significant correlations are based on the significance level (p) when the value of p is equivalent or under 0.05 ($p \leq 0.05$). However, another non-parametric test that is used under the context of this evaluation study is Spearman’s correlation test. This one is used to identify the important connections between two ordinal scale measured variables. Correlations found through this test are being ranked by the degree of relationship strength between the examined factors, and this measure is being presented by the Spearman's coefficient defined as (r_s).

Psychological factors analysis through demographical differences

In this section, the relation between demographical factors and the other features consisting this indoor soundscape study are examined through the psychological factors (Expectation, Perception and Reaction). The assessment of the importance given to the space experience factors is evaluating the student’s expectation of an architecture studio’s environment. While the quality assessment is evaluating their reaction to the case studio. In addition, users’ perception of the soundscape of the observed space is evaluated by annoyance ratings to sound sources. In contrast the reaction to these ones is assessed by preference/disturbance ratings. The approach followed in this part of the analysis rely upon the contextual experience model by Dokmeci and Kang (2017), where they presented a study of the indoor public sound environment through the eye of expectation, reaction and perception of the space users. Therefore, the impact of the demographical factors on these variables is one of the focal considerations regarding the sound perception and space experience analysis. Furthermore, the Mann-Whitney U test is used to discover whether the quality and importance of the factors defining the space experience, or the perception of certain sound sources existing in the architecture studio’s soundscape, differ statistically based on gender or education level. Whereas Kruskal Wallis test is used to explore these differences relying on the time spent variable.

Expectation (Importance of space experience factors)

The results show statistically significant findings between the expectation factor and gender differences. Mann-Whitney test indicated that ‘Level of thermal comfort’ was significantly rated as more important for female users (Mean= 4.45) than for male users (Mean= 4.13), (U=3693,5, $p<0.05$). Similar findings revealed that ‘Brightness of lighting’ ($p<0.05$) and ‘Architecture studio planning in terms of human scale’ ($p<0.05$) factors are also estimated to be important by female users more than males (Figure 4.6). On the other hand, 4^{th} grade Senior users give more importance to the ‘Level of reverberation (echo)’ ($p<0.05$) than the 1^{st} grade Freshman users as shown in Figure 4.7.

Perception (Annoyance due to sound sources)

Regarding the statistical analysis of annoyance assessment and gender relationship, findings presented in Figure 4.8 revealed that female participants were less annoyed by the sound of ‘Mechanical fan/AC’ ($p<0.05$) comparing to the male participants. Further, males were slightly annoyed by the sound of ‘Page turning’ ($p<0.05$); moderately annoyed by the sound of ‘Model making’ ($p<0.05$); and very annoyed by the sound of ‘Doors slamming’ ($p<0.05$) when compared to female users whom the majority of them were not annoyed by any of these sound sources.

Additionally, a statistically significant relationship was found between the education level and the perception of community sounds annoyance as shown in Figure 4.9. Results showed that the distribution in the groups of Senior and Freshman students differed significantly. Senior participants perceived the sounds of ‘Speech’ ($p<0.05$) and ‘Whispering’ ($p<0.05$) as more annoying than Freshman participants did. Moreover, Seniors were moderately annoyed by the sound coming from ‘Groups discussion’ ($p<0.05$), and very annoyed by the sound of ‘Laughter’ ($p<0.05$). In contrast, the majority of 1^{st} grade students were annoyed by the sound of ‘Individual feedbacks’ ($p<0.05$) more than 4^{th} grade students who had a tendency to find it less annoying.

Figure 4.6: Expectation ratings regarding the Importance of the space factors showing significant differences in terms of gender

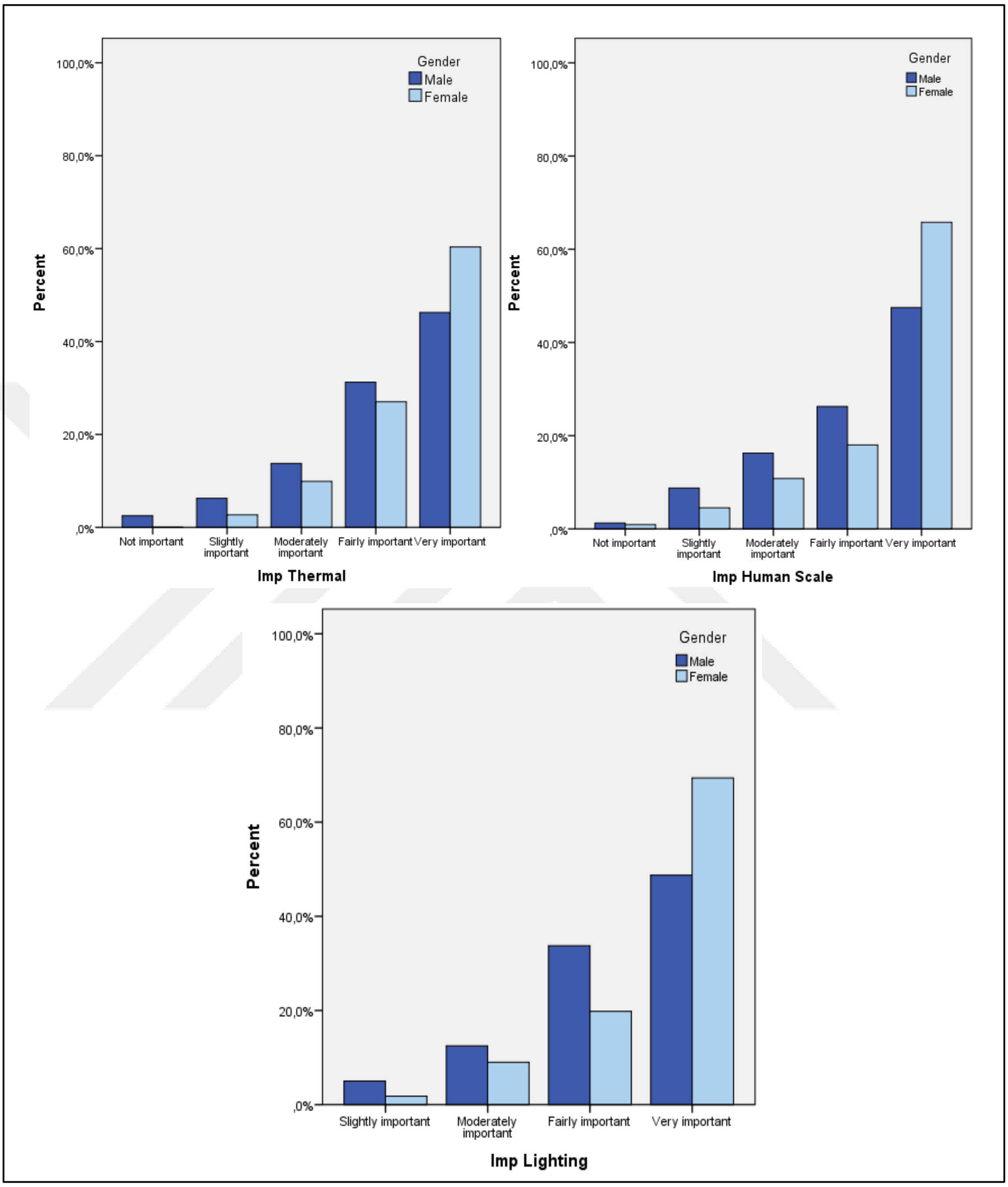
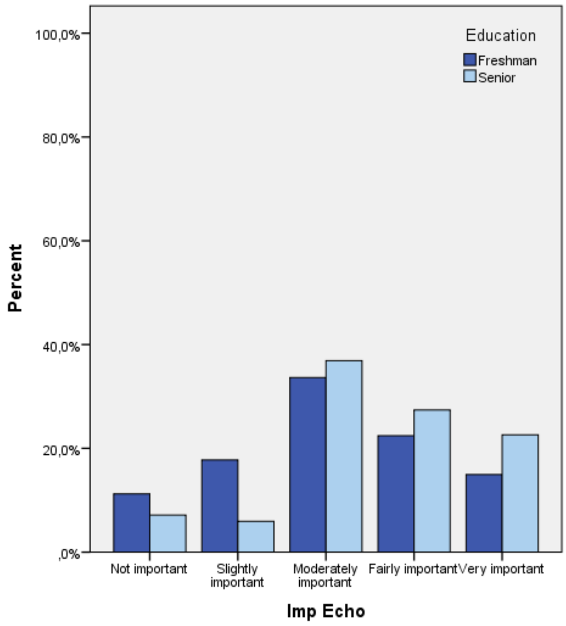


Figure 4.7: Expectation ratings regarding the Importance of the space factors showing significant differences in terms of education level



On the other hand, 'Time spent in hours' evaluation was also substantial in the perception analysis. The statistical test presented significant variances for the time students spend in their studio and the perception of annoyance from certain sounds (Figure 4.10). Users who stay in the studio for more than 8 hours are more annoyed by the sound coming from 'Mechanical fan/AC' ($p<0.05$). Conversely, those who spend less than 8 hours per week in the architecture studio tend to be more annoyed by the sound of 'Whispering' ($p<0.05$) than those who spend 8 hours or more. Also, activity sounds such as 'Mouse click' ($p<0.05$); and 'Model making' ($p<0.05$) are perceived as not at all annoying by those who spend 8 hours or less in the case space, but for users who occupy the space for more time, the majority think that 'Mouse click' sound is slightly annoying, and 'Model making' sound is moderately annoying.

Figure 4.8: Perception ratings regarding annoyance from sound sources showing significant differences in terms of gender

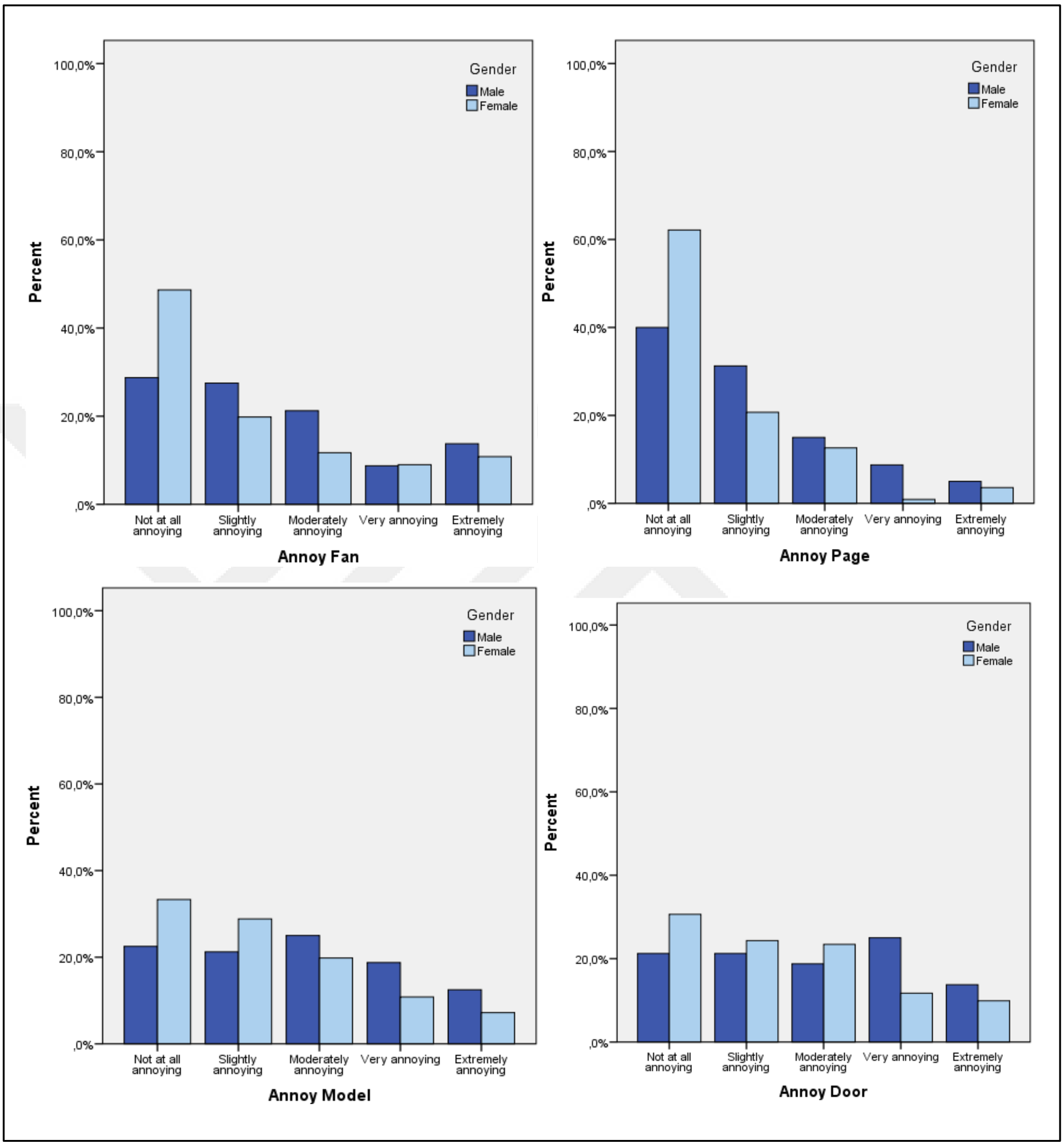


Figure 4.9: Perception ratings regarding the annoyance from sound sources showing significant differences in terms of Education level

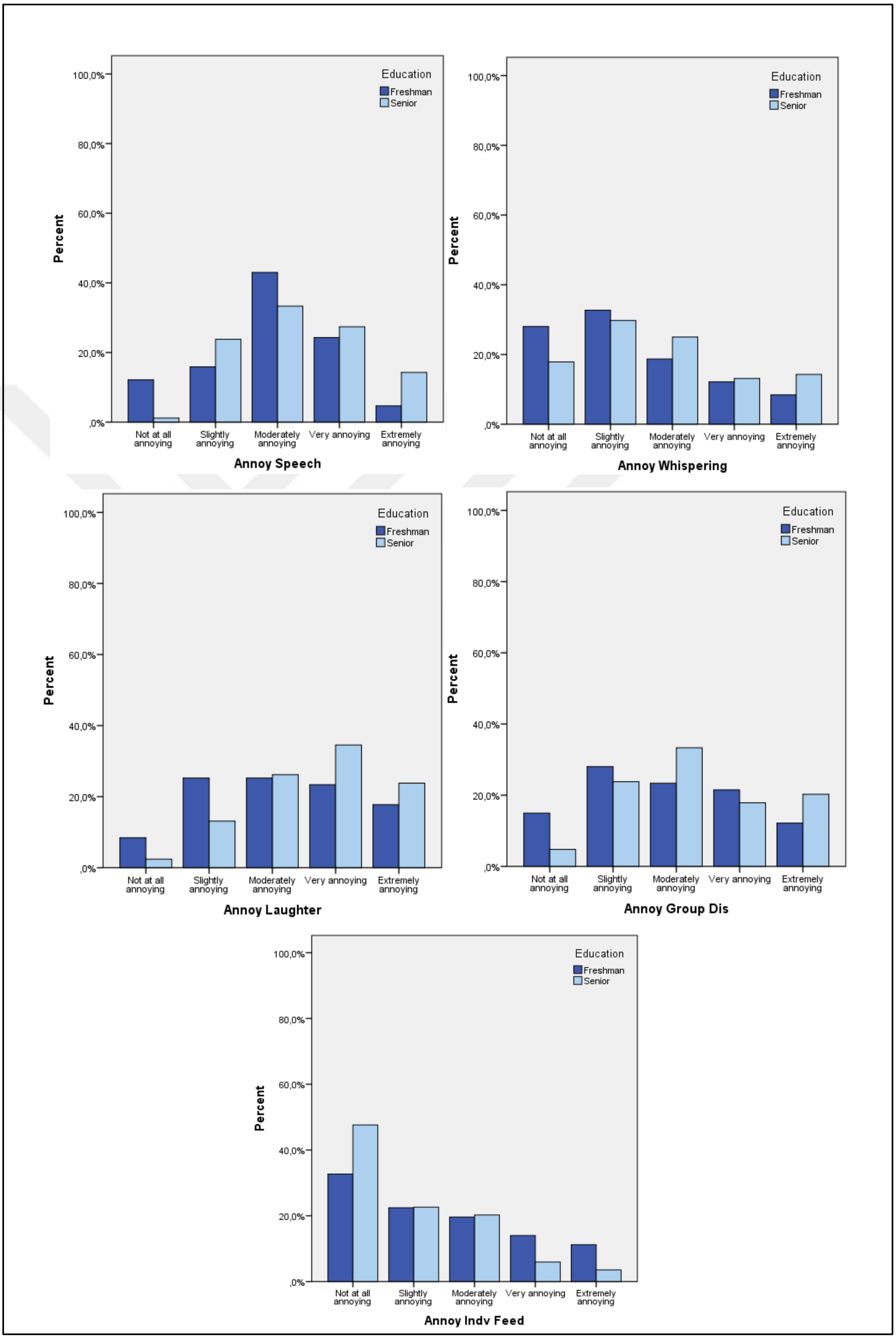
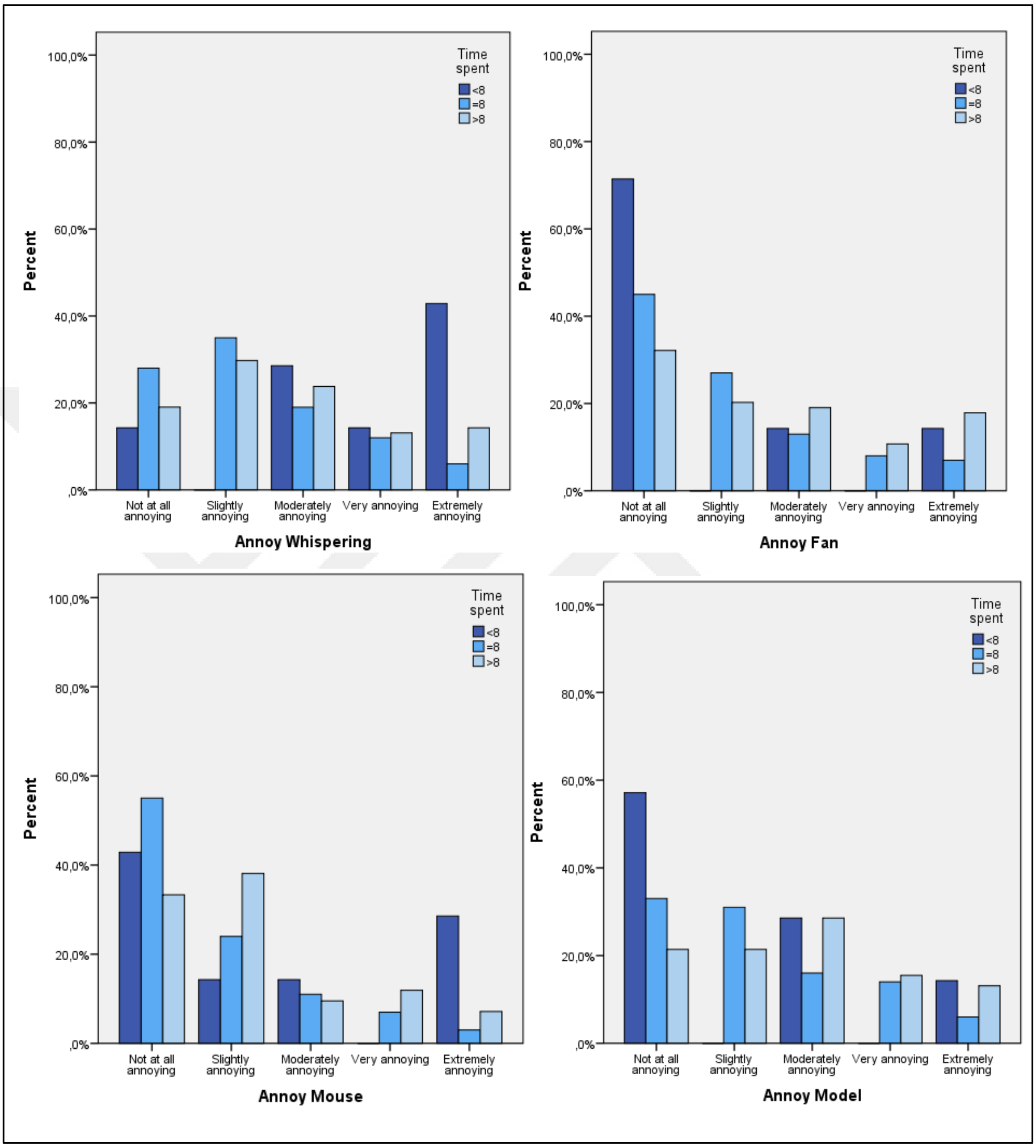


Figure 4.10: Perception ratings regarding the annoyance from sound sources showing significant differences in terms of Time spent



Reaction (Quality of space experience factors)

Important findings were identified between the education level and the reaction to certain physical environment and architectural design factors (Figure 4.11). Quality assessments for the 'Level of indoor air quality' ($p<0.05$) revealed that participants from the 1^{st} grade comparatively rated the 'indoor air quality' of their studio as good when compared to the 4^{th} grade participants. They also found the 'Level of thermal comfort' ($p<0.05$) in the case study to be more comfort, and the 'Level of indoor humidity' ($p<0.05$) to be more humid than the Senior respondents did, even though most of them occupy the same space. On the other hand, contrasting ranks of quality were identified by the space users concerning other factors such as 'Architecture studio planning in terms of human scale' ($p<0.05$); and 'Form and function relationship' ($p<0.05$). 1^{st} grade students found the studio to be related in terms of the space's form and function relationship more than the 4^{th} grades. Besides, they classified their architecture studio as somewhat rational in terms of human scale, unlike Senior participants who found it to be moderate.

Reaction (Preference of / disturbance from sound sources)

The statistical test was also applied to analyse the connections between the reaction to sound sources and the demographical variables. This part focused on the scores given according to the user's preference or disturbance from the sound. Gender and education level were found to be significantly linked to these assessments. Ratings presented in Figure 4.12 show that the majority of female users were very disturbed by the sound of the 'Overall noise' ($p<0.05$) in the case architecture studio when compared to the majority of male users who had a moderate reaction to it.

Figure 4.11: Reaction ratings regarding the quality of the space factors showing significant differences in terms of education level

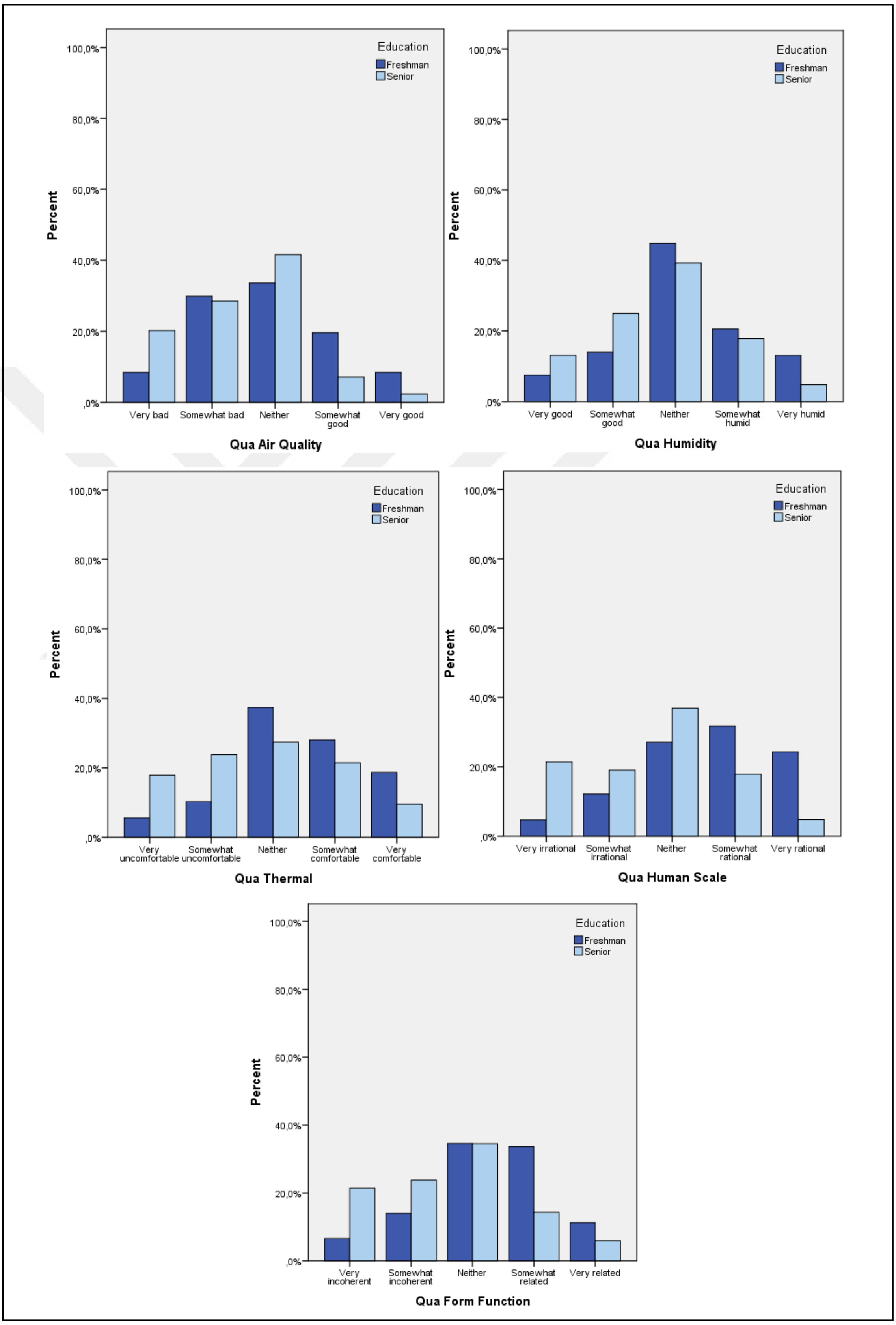
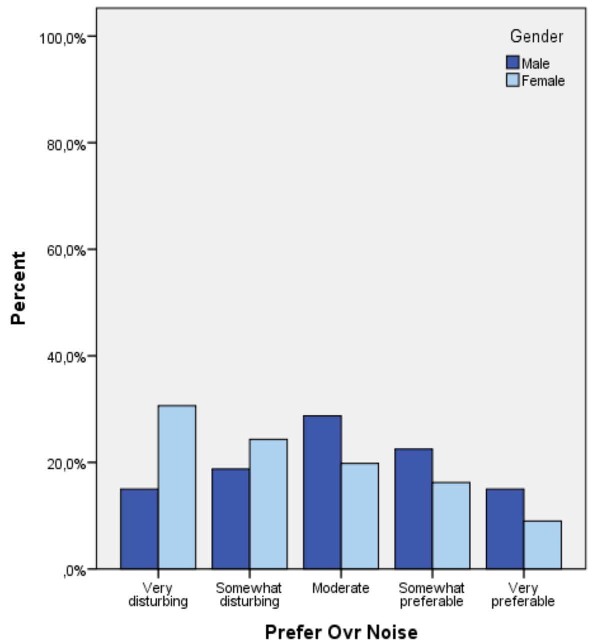
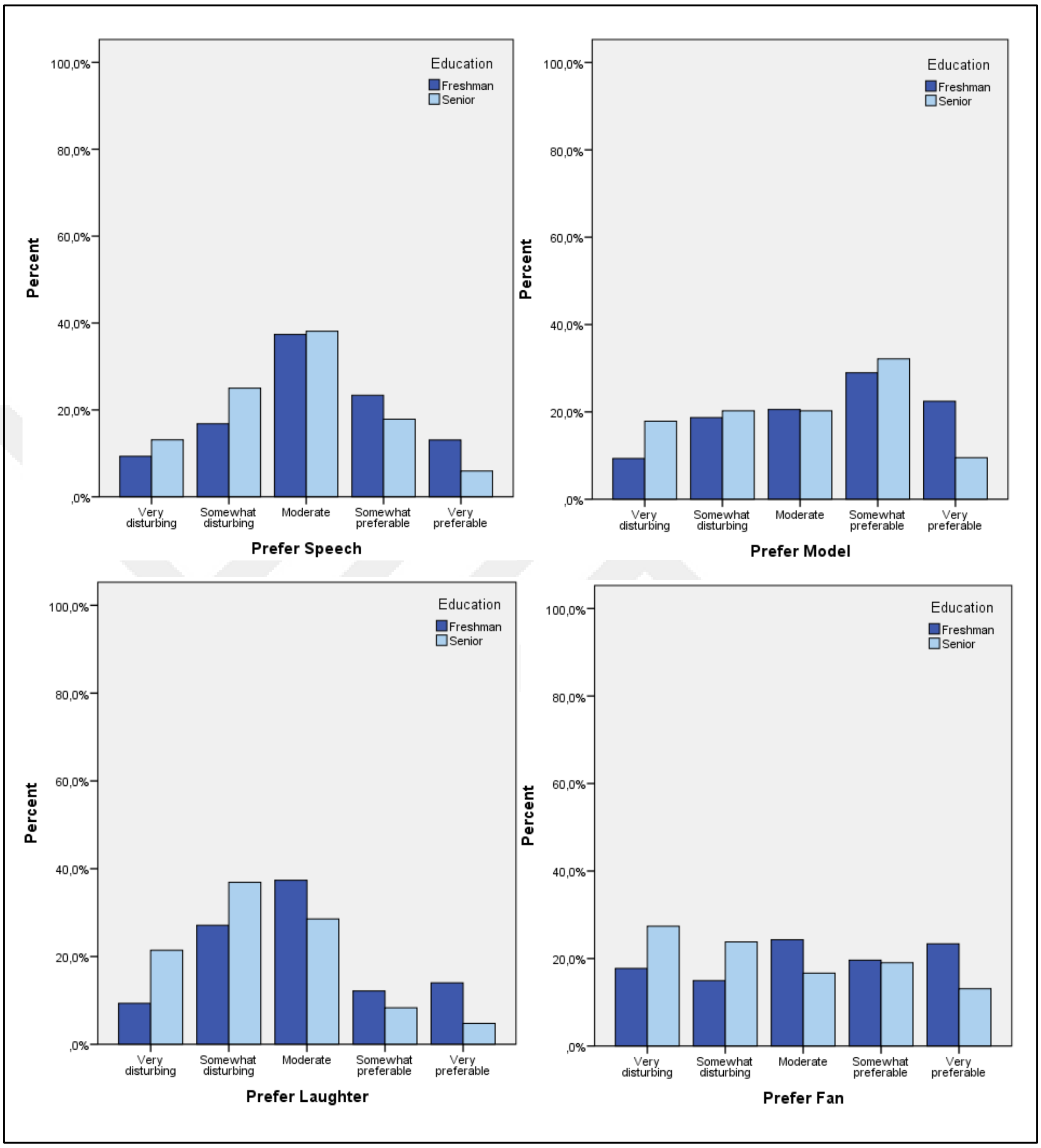


Figure 4.12: Reaction ratings regarding preference/ disturbance from sound sources showing significant differences in terms of gender



On the other hand, users from the 1st grade (Mean= 3.14) found community sound sources such as 'Speech' ($p<0.05$) to be more preferable than 4th grade users (Mean= 2.79). Another sound source they found it to be less disturbing compared to Senior students was the activity sound source 'Model making' ($p<0.05$). Similarly, Freshman students rated the sound of 'Laughter' ($p<0.05$), and 'Mechanical fan/AC' ($p<0.05$) as moderate, unlike the majority of participants from the 4th grade who found 'laughter' to be somewhat disturbing, and 'Mechanical fan/AC' to be a very disturbing sound (Figure 4.13).

Figure 4.13: Reaction ratings regarding preference/disturbance from sound sources showing significant differences in terms of education level



Correlations between Importance of space experience factors

The non-parametric Spearman's correlation test was used to bring to light the existing significant associations between the different variables representing the architecture studio environment. The first set of analyses focused on the correlations between the importance of space experience factors within each other (Table 4.1). The results showed that the importance of each of ‘Level of indoor humidity’ (r_s=0.469, p<0.01), ‘Level of thermal comfort’ (r_s=0.534, p<0.01), ‘Brightness of lighting’ (r_s=0.427, p<0.01), ‘Level of spaciousness’ (r_s=0.489, p<0.01), ‘From and function relationship’ (r_s=0.453, p<0.01), and ‘Architectural studio planning in terms of human scale’ (r_s=0.481, p<0.01) is significantly correlated with the importance of ‘Level of indoor air quality’. This indicates that the indoor air quality of an indoor space is highly related to the architectural design and physical environment conditions. Furthermore, the factor indicated as ‘Architectural studio planning in terms of human scale’ is correlated in terms of importance with the factors of ‘From and function relationship’ (r_s=0.599, p<0.01), ‘Level of spaciousness’ (r_s=0.428, p<0.01), ‘Brightness of lighting’ (r_s=0.454, p<0.01), ‘Level of thermal comfort’ (r_s=0.429, p<0.01), and ‘Level of indoor air quality’ (r_s=0.481, p<0.01). These significant connections explain how the studio planning in terms of the human scale factor is affected by the physical environment aspects. Similarly, a correlation of two of the architectural design factors regarding importance which are ‘Level of spaciousness’ (r_s=0.407, p<0.01), and ‘Architectural studio planning in terms of human scale’ (r_s=0.599, p<0.01) were found to be moderately related with the importance level of the ‘From and function relationship’ factor. One more variable that was related to this one which is the ‘Level of acoustic comfort’ (r_s=0.411, p<0.01) indicates the importance of the acoustic comfort factor in the architectural design of an indoor space.

Table 4.1: Spearman 's correlations between space experience factors regarding Importance

Factor 1	Factor 2	Spearman’s Rho r_s (Correlation coefficient)	Strength	Significance
Imp Air Quality	Imp Humidity	.469	Moderate	<0.01
	Imp Thermal	.534	Moderate	<0.01
	Imp Lighting	.427	Moderate	<0.01
	Imp Spaciousness	.489	Moderate	<0.01
	Imp Human Scale	.481	Moderate	<0.01

	Imp Form Function	.453	Moderate	<0.01
Imp Human Scale	Imp Air Quality	.481	Moderate	<0.01
	Imp Thermal	.429	Moderate	<0.01
	Imp Lighting	.454	Moderate	<0.01
	Imp Spaciousness	.428	Moderate	<0.01
	Imp Form Function	.599	Moderate	<0.01
Imp Form Function	Imp Air Quality	.453	Moderate	<0.01
	Imp Acoustic	.411	Moderate	<0.01
	Imp Spaciousness	.407	Moderate	<0.01
	Imp Human Scale	.599	Moderate	<0.01

Correlations between Quality of space experience factors

The results of the correlations between space experience factors regarding quality ratings are presented in Table 4.2. The quality assessment of 'Level of acoustic comfort' factor has also proved some moderately significant intercorrelations with the quality of 'Level of sounds (loudness)' (r_s=0.474, p<0.01), and 'Intelligibility of sounds (definition)' (r_s=0.430, p<0.01). Moreover, the quality of 'Intelligibility of sounds (definition)' was found to have another correlation with 'Level of reverberation (Echo)' (r_s=0.273, p<0.01), and 'Brightness of lighting' (r_s=0.403, p<0.01). Also, the 'Level of sounds (loudness)' quality was proved to be correlated with 'Level of reverberation (Echo)' (r_s=0.253, p<0.01) as well. These results highlight the interconnection perceived by the studio users regarding the quality of different physical environment factors within each other. Additionally, the quality ranking of 'The ability to locate via sounds' factor was found to be in correlation with the 'Way finding (ability to find your way around)' (r_s=0.422, p<0.01), which indicates the crucial relation between sound perception and the architectural design factors.

Table 4.2: Spearman 's correlations between space experience factors regarding Quality

Factor 1	Factor 2	Spearman's Rho r_s (Correlation coefficient)	Strength	Significance
Qua Acoustic	Qua Intelligibility	.430	Moderate	<0.01
	Qua Loudness	.474	Moderate	<0.01
Qua Intelligibility	Qua Lighting	.403	Moderate	<0.01
	Qua Echo	.273	Weak	<0.01
Qua Loudness	Qua Echo	.253	Weak	<0.01
Qua Locate	Qua Way finding	.422	Moderate	<0.01

Correlations between Importance and Quality of space experience factors

The aspect this analysis focused on was the associations within importance and quality assessments of the space experience factors. Findings revealed a weak correlation between the importance and quality of the same factor which is the 'Level of reverberation (Echo)' (r_s=0.211, $p<0.01$). And a very weak one between importance and quality of 'Intelligibility of sounds (definition)' (r_s=0.197, $p<0.01$). The majority of the participants classified these two factors as moderate in terms of importance and quality, which indicates that the students' expectation of some the acoustic environment features in an architecture studio is comparatively similar to the actual ones in the case study. However, the importance of 'Level of crowd (user's density in the space)' that was rated to be a very important factor, was correlated with the quality of 'Level of spaciousness' (r_s=0.159, $p<0.05$) which was evaluated to be moderate in the examined studio. The statistical test also revealed that students rated the importance of 'Level of sounds (loudness)' (r_s=0.156, $p<0.05$), 'Level of spaciousness' (r_s=0.160, $p<0.05$), and 'Architectural studio planning in terms of human scale' (r_s=0.148, $p<0.05$) as very important, and 'The ability to locate via sounds' (r_s=0.153, $p<0.05$) as moderately important in an architecture studio space. A very weak correlation was found between the importance of these four factors with the quality of 'Intelligibility of sounds (definition)' of the case studio which was ranked as moderate by the users. This correlation shows that subconsciously students understand that intelligibility is related to the source and source properties. The patterns identified in this analysis are all summarised in the Table 4.3 below.

Table 4.3: Spearman 's correlations between space experience factors regarding Importance and Quality

Factor 1	Factor 2	Spearman's Rho r_s (Correlation coefficient)	Strength	Significance
Qua Echo	Imp Echo	.211	Weak	<0.01
Qua Intelligibility	Imp Intelligibility	.197	Very weak	<0.01
Qua Spaciousness	Imp Density	.159	Very weak	<0.05
Qua Intelligibility	Imp Loudness	.156	Very weak	<0.05
	Imp Spaciousness	.160	Very weak	<0.05
	Imp Human scale	.148	Very weak	<0.05
	Imp Locate	.153	Very weak	<0.05

Correlations between sound source perception

The statistical test revealed significant findings concerning the relationships between the different sound sources of the case architecture studio. Very strong, strong and moderately significant correlations are summarised in the tables below for each annoyance (Table 4.4) and preference/disturbance (Table 4.5) assessments. The majority of correlations were between activity sounds and mechanical sounds, or within the activity sounds only. For instance, results showed a significant connection regarding the preference/disturbance assessment of 'Mouse click' (r_s =473, $p<0.01$), 'Computer keyboard' (r_s =430, $p<0.01$), 'Walking/Footsteps' (r_s=486, $p<0.01$), and 'Mobile phones' (r_s =464, $p<0.01$) with the sound of 'Doors slamming', which is classified as the most disturbing sound source in the architecture studio environment in this study.

Table 4.4: Spearman 's correlations between sound sources Annoyance

Source 1	Source 2	Spearman's Rho r_s (Correlation coefficient)	Strength	Significance
Annoy Speech	Annoy Laughter	.434	Moderate	<0.01
Annoy Mouse	Annoy Keyboard	.819	Very Strong	<0.01
	Annoy Indv Feed	.403	Moderate	<0.01
	Annoy Page	.459	Moderate	<0.01
	Annoy Footstep	.418	Moderate	<0.01
Annoy Keyboard	Annoy Model	.406	Moderate	<0.01
	Annoy Page	.535	Moderate	<0.01
Annoy Model	Annoy Page	.456	Moderate	<0.01
	Annoy Footstep	.448	Moderate	<0.01
Annoy Page	Annoy Footstep	.534	Moderate	<0.01
Annoy Door	Annoy Phone	.409	Moderate	<0.01
Annoy Phone	Annoy Music	.439	Moderate	<0.01
Annoy Elevator	Annoy Fan	.472	Moderate	<0.01
Annoy Fan	Annoy Traffic	.482	Moderate	<0.01
Annoy Traffic	Annoy Ovr Noise	.478	Moderate	<0.01

Table 4.5: Spearman 's correlations between sound sources Preference/Disturbance

Source 1	Source 2	Spearman's Rho r_s (Correlation coefficient)	Strength	Significance
Prefer Speech	Prefer Laughter	.460	Moderate	<0.01
Prefer Whispering	Prefer Mouse	.402	Moderate	<0.01

	Prefer Keyboard	.442	Moderate	<0.01
Prefer Mouse	Prefer Keyboard	.882	Very strong	<0.01
	Prefer Page	.588	Moderate	<0.01
	Prefer Footstep	.548	Moderate	<0.01
	Prefer Door	.473	Moderate	<0.01
	Prefer Elevator	.414	Moderate	<0.01
	Prefer Fan	.412	Moderate	<0.01
Prefer Keyboard	Prefer Model	.422	Moderate	<0.01
	Prefer Page	.604	Strong	<0.01
	Prefer Footstep	.546	Moderate	<0.01
	Prefer Door	.430	Moderate	<0.01
	Prefer Elevator	.420	Moderate	<0.01
Prefer Model	Prefer Page	.401	Moderate	<0.01
Prefer Page	Prefer Footstep	.514	Moderate	<0.01
	Prefer Elevator	.463	Moderate	<0.01
Prefer Footstep	Prefer Door	.486	Moderate	<0.01
	Prefer Phone	.488	Moderate	<0.01
Prefer Door	Prefer Phone	.464	Moderate	<0.01
Prefer Phone	Prefer Music	.559	Moderate	<0.01
Prefer Elevator	Prefer Fan	.512	Moderate	<0.01
	Prefer Traffic	.461	Moderate	<0.01
Prefer Fan	Prefer Traffic	.508	Moderate	<0.01
Prefer Traffic	Prefer Ovr Noise	.591	Moderate	<0.01

Correlations between space experience factors and sound source perception

Factors under space experience were found to have significant correlations with the sound sources under soundscape perception variable. Statistical results proved that the quality of 'Form and function relationship' in the examined architecture studio was highly related to 'Door slamming' (r_s =210, $p<0.01$), 'Mechanical fan/AC'(r_s =230, $p<0.01$), 'Personal music player' (r_s =189, $p<0.01$), 'Mobile phones' (r_s =184, $p<0.05$), 'Groups discussion' (r_s =175, $p<0.05$), and 'Laughter' (r_s =162, $p<0.05$) regarding preference/disturbance rankings, and to 'Walking/footsteps' (r_s =144, $p<0.05$), 'Personal music player' (r_s= -163, $p<0.05$), and 'Laughter' (r_s = -151, $p<0.05$) in terms of annoyance rankings.

Similarly, to define the quality of the case studio's planning and design, a question whether if it is rational or irrational in terms of human scale was asked. Eight different sound sources regarding preference/disturbance ratings which are 'Door slamming' (r_s =200, $p<0.01$), 'Model making' (r_s =188, $p<0.01$), 'Page turning' (r_s =168, $p<0.05$), 'Walking/footsteps' (r_s =169, $p<0.05$), 'Laughter' (rs=161, $p<0.05$), 'Mechanical fan/AC'(r_s =245, $p<0.01$), 'Personal music player' (r_s =223, $p<0.01$), and 'Overall noise' (r_s =196, $p<0.01$) were found to be significantly correlated to this question.

Another space experience factor which is 'Way finding (ability to find your way around)' was affected by the annoyance of sounds like 'Whispering' (r_s =-199, $p<0.01$), 'Individual feedbacks' (r_s =162, $p<0.05$), 'Mouse click' (r_s =192, $p<0.05$), 'Computer keyboard' (r_s =160, $p<0.05$), and the preference/disturbance of 'Overall noise' (r_s =178, $p<0.05$). Also the factor of 'Level of crowed (users' density in the space)' was significantly correlated with the sounds of 'Speech' (r_s =210, $p<0.01$), 'Laughter' (r_s =306, $p<0.01$), 'Individual feedbacks' (r_s=-154, $p<0.05$), 'Mechanical fan/AC' (r_s =154, $p<0.05$), and 'Overall noise' (r_s =179, $p<0.05$).

On the other hand, the quality of the 'Level of indoor air quality' and 'Level of thermal comfort' were also found to be related to many sound sources. 'Speech' (r_s =185, $p<0.05$), 'Walking/footsteps' (r_s =161, $p<0.05$), 'Doors slamming' (r_s =187, $p<0.01$), and 'Overall noise' (r_s =188, $p<0.01$) are the sounds related to the 'Level of thermal comfort' factor. Whereas, for the factor of 'indoor air quality' it was correlated with sounds like

‘Computer keyboard’ (r_s=150, $p<0.05$), ‘Page turning’ (r_s =147, $p<0.05$), ‘Speech’ (r_s =155, $p<0.05$), and ‘Doors slamming’ (r_s =153, $p<0.05$).

Similarly, the Importance of the acoustic factor ‘Level or reverberation (Echo)’ was significantly correlated with the sounds coming from the users such as ‘Whispering’ (r_s =166, $p<0.05$), and ‘Groups discussion’ (r_s =184, $p<0.05$). It was also related to other mechanical sound sources like ‘Traffic noise’ (r_s =220, $p<0.01$), ‘Elevator’ (r_s =196, $p<0.01$), and ‘Mechanical fan/Ac’ (r_s =179, $p<0.05$), in addition to the ‘Overall noise’ (r_s =185, $p<0.05$) sound. Table 4.6 shows the correlations founded between the factors reported in this analysis.

Table 4.6: Spearman 's correlations between space experience factors and sound source perception based on space experience

Space experience factor	**Sound source**	**Spearman’s Rho r_s (Correlation coefficient)**	**Strength**	**Significance**
Qua Form function	Prefer Door	.210	Weak	<0.01
	Prefer Fan	.230	Weak	<0.01
	Prefer Music	.189	Very weak	<0.01
	Prefer Phone	.184	Very weak	<0.05
	Prefer Group Dis	.175	Very weak	<0.05
	Prefer Laughter	.162	Very weak	<0.05
	Annoy Footstep	.144	Very weak	<0.05
	Annoy Music	-.163	Very weak	<0.05
	Annoy Laughter	-.151	Very weak	<0.05
Qua Human scale	Prefer Door	.200	Weak	<0.01
	Prefer Music	.233	Weak	<0.01
	Prefer Fan	.245	Weak	<0.01
	Prefer Laughter	.161	Very weak	<0.05

	Prefer Model	.188	Very weak	<0.01
	Prefer Page	.168	Very weak	<0.05
	Prefer Footstep	.169	Very weak	<0.05
	Prefer Ovr noise	.196	Very weak	<0.01
Qua Way finding	Annoy Whispering	.199	Very weak	<0.01
	Annoy Indv feed	-.162	Very weak	<0.05
	Annoy Mouse	-.192	Very weak	<0.01
	Annoy Keyboard	-.160	Very weak	<0.05
	Pref Ovr Noise	.178	Very weak	<0.05
Qua Density	Pref Speech	.210	Weak	<0.01
	Pref Laughter	.306	Moderate	<0.01
	Pref Indv feed	-.154	Very weak	<0.05
	Pref Fan	.154	Very weak	<0.05
	Pref Ovr Noise	.179	Very weak	<0.05
Qua Air quality	Annoy Keyboard	.150	Very weak	<0.05
	Annoy Page	.147	Very weak	<0.05
	Pref Speech	.155	Very weak	<0.05
	Pref Door	.153	Very weak	<0.05
Qua Thermal	Pref Ovr Noise	.188	Very weak	<0.01
	Pref Door	.187	Very weak	<0.01
	Pref Speech	.185	Very weak	<0.05
	Pref Footstep	.161	Very weak	<0.05
Imp Echo	Annoy Traffic	.220	Weak	<0.01
	Annoy Whispering	.166	Very weak	<0.05
	Annoy Group Dis	.184	Very weak	<0.05
	Annoy Elevator	.196	Very weak	<0.01

	Annoy Fan	.179	Very weak	<0.05
	Annoy Ovr Noise	.185	Very weak	<0.05

The statistical test revealed more significant correlations that highlight the effect of the space factors on the perception of some sounds (Table 4.7). Results showed that the reaction towards the preference/disturbance of the sound of 'Laughter' was significantly correlated to the importance of 'Level of indoor air quality' (r_s =-176, $p<0.05$), 'Different types of sound' (r_s=165, $p<0.05$), and 'Level of spaciousness' (r_s =-175, $p<0.05$). As well as the quality of 'Level of crowd (user's density in the space)' (r_s =306, $p<0.01$), 'Architecture studio planning in terms of human scale' (r_s =161, $p<0.05$), and 'Form and function relationship' (r_s=162, $p<0.05$). On the other hand, the importance of 'Noise from neighbouring spaces' (r_s =182, $p<0.05$) was the only significant factor found to be in correlation with the perception of annoyance from the sound of 'Laughter'.

Moreover, two more community sounds were found to be related to the space experience factors. The assessment of annoyance from 'Groups discussion' sound revealed a significant correlation with the importance of 'Brightness of lighting' (r_s =147, $p<0.05$) and 'Ability to locate via sounds' (r_s =160, $p<0.05$), in addition to a correlation with the acoustic factors 'Level of acoustic comfort' (r_s =173, $p<0.05$), and 'Level of reverberation (Echo)' (r_s =184, $p<0.05$).

Substantial correlations were also found between the preference/disturbance from the sound emitted during 'Individual feedbacks' and architectural design factors 'Level of crowd (user's density in the space)' (r_s =-154, $p<0.05$), 'Form and function relationship' (r_s =145, $p<0.05$), and 'Architecture studio planning in terms of human scale' (r_s =178, $p<0.05$). Additionally, the 'Individual feedbacks' sound source was related to acoustic factors as well, such as 'Different types of sounds' (r_s =-146, $p<0.05$), 'Level of sounds (loudness)' (r_s =-145, $p<0.05$) and 'Intelligibility of sounds (definition)' (r_s =-148, $p<0.05$).

Furthermore, the importance of the factors named as 'Ability to locate via sounds' (r_s =209, $p<0.01$), 'Level of reverberation (Echo)' (r_s =185, $p<0.05$), 'Level of thermal comfort' (r_s =188, $p<0.05$); and the quality of 'Level of crowd (user's density in the space)' (r_s =179, $p<0.05$), 'Way-finding' (r_s =178, $p<0.05$), and 'Architecture studio in terms of human scale' (r_s =196, $p<0.01$), were significantly correlated with the 'Overall noise' sound.

The reaction to preference/disturbance of 'Doors slamming' sound was significantly correlated with the importance of five different factors named as 'Form and function relationship' (r_s =210, $p<0.01$), 'Architecture studio in terms of human scale' (r_s =200, $p<0.01$), 'Level of indoor air quality' (r_s =153, $p<0.05$), 'Level of thermal comfort' (r_s =187, $p<0.05$) and 'Level of acoustic comfort' (r_s =166, $p<0.05$). In contrast, the annoyance perception of the 'Doors slamming' sound was related to the importance of 'Noise from neighbouring spaces' factor (r_s =166, $p<0.05$). Another relevant finding was related to the preference/disturbance from 'Walking/footsteps' sound. Significant correlations were found between this sound and the quality of 'Level of thermal comfort' (r_s =161, $p<0.05$), 'Noise from neighbouring spaces' (r_s =161, $p<0.05$), and 'Architecture studio in terms of human scale' (r_s =169, $p<0.05$).

Table 4.7: Spearman 's correlations between sound source perception and space experience factors based on sound sources

Sound source	Space experience factor	Spearman's Rho r_s (Correlation coefficient)	Strength	Significance
Prefer Laughter	Imp Air quality	-.176	Very weak	<0.05
	Imp Sound type	.165	Very weak	<0.05
	Imp Spaciousness	-.175	Very weak	<0.05
	Qua Density	.306	Moderate	<.0.01
	Qua Human scale	.161	Very weak	<0.05
	Qua Form function	.162	Very weak	<0.05
Annoy Laughter	Imp Noise	.182	Very weak	<0.05
Pref Indv feed	Imp Loudness	-.145	Very weak	<0.05
	Imp Sound type	-.146	Very weak	<0.05

	Imp Human scale	.178	Very weak	<0.05
	Imp Form function	.145	Very weak	<0.05
	Imp Density	-.154	Very weak	<0.05
Annoy Indv feed	Imp Intelligibility	-148	Very weak	<0.05
Annoy Group	Imp Lighting	.147	Very weak	<0.05
	Imp Locate	.160	Very weak	<0.05
	Imp Acoustic	.173	Very weak	<0.05
	Imp Echo	.184	Very weak	<0.05
Pref Ovr Noise	Annoy Echo	.185	Very weak	<0.05
	Annoy Thermal	.188	Very weak	<0.05
	Annoy Locate	.209	Moderate	<0.01
Pref Ovr Noise	Qua Way finding	.178	Very weak	<0.05
	Qua Density	.179	Very weak	<0.05
	Qua Human scale	.196	Very weak	<0.05
Pref Door	Qua Air quality	.153	Very weak	<0.05
	Qua Thermal	.187	Very weak	<0.05
	Qua Acoustic	.166	Very weak	<0.05
	Qua Human Scale	.200	Moderate	<0.01
	Qua Form function	.210	Moderate	<0.01
Annoy Door	Imp Noise	.166	Very weak	<0.05
Prefer Footstep	Qua Thermal	.161	Very weak	<0.05
	Qua Noise	.161	Very weak	<0.05
	Qua Human scale	.169	Very weak	<0.05
	Qua Form function	.144	Very weak	<0.05

4.4. FINDINGS AND DISCUSSION

Throughout this study a subjective evaluation has been followed by focusing on the factors related to space experience and the perception of sound sources in the architecture studio classroom. Several statistical results have been identified and presented in this research from the conducted indoor soundscape questionnaire. Findings have revealed significant relations between the evaluated variables. Prior studies evaluating different enclosed environments were done by Dokmeci and Kang (2012b; 2017), Ikhwanuddin et al. (2017), and Acun and Yilmazer (2018b). These researches have also focused on evaluating the indoor soundscape through a subjective point. Their findings revealed significant relations between the space factors and the user's auditory perception. The obtained statistical results from these researches presented important conclusions about demographical factors and how they affect the psychological factors. In addition, other important findings were revealed regarding the sound and space interconnection.

Findings and discussion on demographical factors differences

In this study the results have shown that psychological factors (Expectation, Perception, Reaction) are notably related to the demographical factors variances. It has been found that gender differences affect the users' expectation regarding the importance of the space experience factors which are, studio planning in terms of human scale, brightness of light, and thermal comfort. These results support the findings presented by Dokmeci and Kang (2012b) and (2017) who demonstrated that expectation on the level of thermal comfort differed according to the gender of the participants from the library case study. In addition, the rating of freshman participants to the reverberation level as one of the least important factors highlights the variance in the level of awareness between them and senior students.

Moreover, perception of sound sources existing in the chosen enclosed environments have also shown a significant difference between the genders. Male users were found to be more sensitive than females in terms of annoyance to mechanical fan/ac, model making, page turning, and especially the sound caused by doors slamming which was perceived as an undesirable sound in the case studio. In contrast, Dokmeci and Kang

(2012b) study findings revealed that gender differences were identified regarding the annoyance by the sounds of mobile phones, music, and laughter.

Contrast findings concerning the education level and annoyance from community sound sources (speech, laughter, whispering, groups discussion, and individual feedbacks) were also presented in this study. Results have identified that 4th grade students were more annoyed by all the community sounds except the one related to individual feedbacks. In contrast, 1st grade students perceived this sound to be more annoying than the others. This may be related to the nature of the course for each of the education levels and to the disposition of the moveable partition walls in each studio. For 1st grade students, their program requires more group work and discussion during the course time, thus, the partition walls in their studio are usually open to get more advantage of the space. This makes the activity sound sources in their studio vary more than the 4th grades, who get individual feedbacks twice a week rather than group discussions and tend to have a quieter sound environment. This may be attributed to the positioning of the moveable partition walls that help in creating isolated classrooms and also lessen the sound sources in their soundscape.

Similarly, the perception of sound annoyance has been found to be affected by the time spent in the architecture studio. Users who spend time more than the course hours in the studio tend to be more annoyed by the sounds of whispering, mechanical fan, model making, and mouse click. These findings support the same results presented by Dokmeci and Kang (2017) where they found that the sound of whispering in an enclosed library environment is significantly related to the long span of time spent by the users in the space. This indicates that spending long time hours in the indoor space increases the users' annoyance from sounds.

Another similar result from Dokmeci and Kang's (2017) research, was their finding regarding the reaction to indoor humidity and indoor air quality conditions, which differed between Undergraduate, Master's, and PhD degree users. Likewise, the statistical tests in this study have indicated that Senior users ranked their studio's quality to be low in terms of indoor air quality and thermal comfort more than freshman users. In contrast, the level of indoor humidity was evaluated to be good by the majority of seniors, unlike freshman users who rated the quality as humid. These findings confirm the effect of the education level variances on the students' awareness of the quality of environmental factors of the space.

Furthermore, the reaction to the overall noise question in terms of preference/disturbance have highlighted the contrast between genders, where female users were more disturbed by the sound. Another significant variance regarding this assessment has been found between the 1st grades and 4th grades concerning their reaction to community (speech and laughter), activity (model making), and mechanical (mechanical fan/ac) sound sources. Overall these findings are in line with the ones reported in another study evaluating the library soundscape by Ikhwanuddin et al. (2017) who identified the sounds of speech, phone, intense discussion in a group, and talks to be perceived as distracting sounds by the space users. In addition, a similar pattern of results was obtained by Acun and Yilmazer (2018b) in their study of evaluating the indoor acoustic environment of open study areas, where they found the sound of speech to be the most disturbing sound. Therefore, it can be determined that the demographical factors have important effects on the sound sources evaluation in the indoor space.

Findings and discussion on space experience factor's correlations

Statistical results have presented significant findings regarding the importance assessment correlations for indoor air quality with other environmental conditions, and with planning in terms of human scale, form and function relationship, and level of spaciousness factors (Figure 4.14). Similarly, the architecture studio planning in terms of human scale variable has been found to be related to more architectural factors, and to brightness of light, thermal comfort, and indoor air quality factors, as shown in Figure 4.15. In addition to that, Figure 4.16 summarises the correlations obtained for the form and function relationship variable that has been found to be related to architectural and environmental factors as well. This indicates the importance of an architectural design or physical factor both can be related to each other, which affect the space experience of the user in the given space. Also, the observed correlation between level of spaciousness and level of crowed, may be related to the students' perception of density in the architectural environment.

Figure 4.14: Statistically significant correlations between Indoor air quality variable and other space factors evaluated by importance ratings

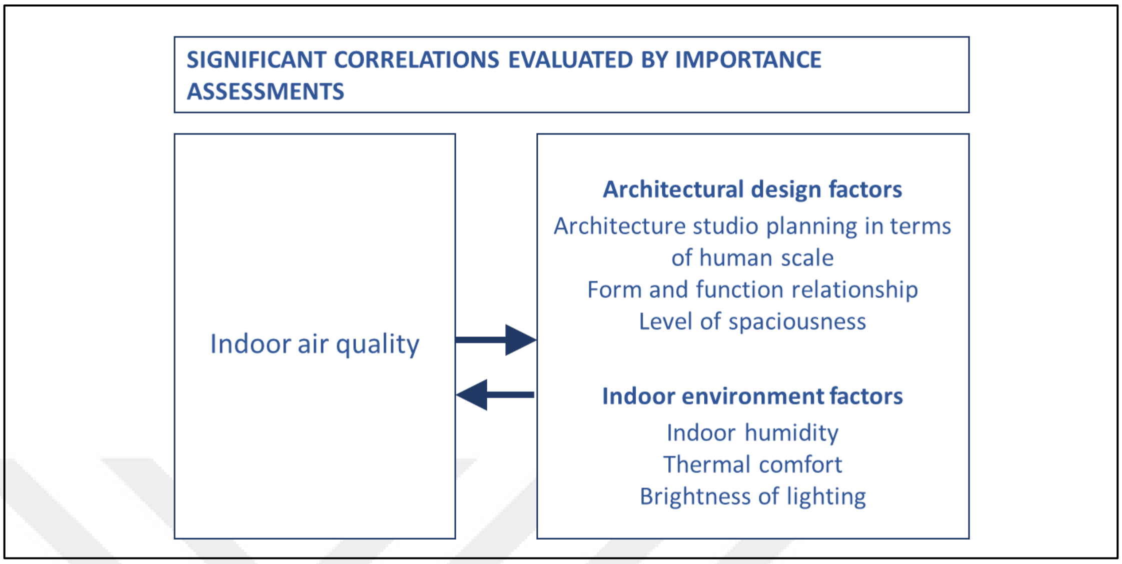


Figure 4.15: Statistically significant correlations between Architecture studio planning in terms of human scale variable and other space factors evaluated by importance ratings

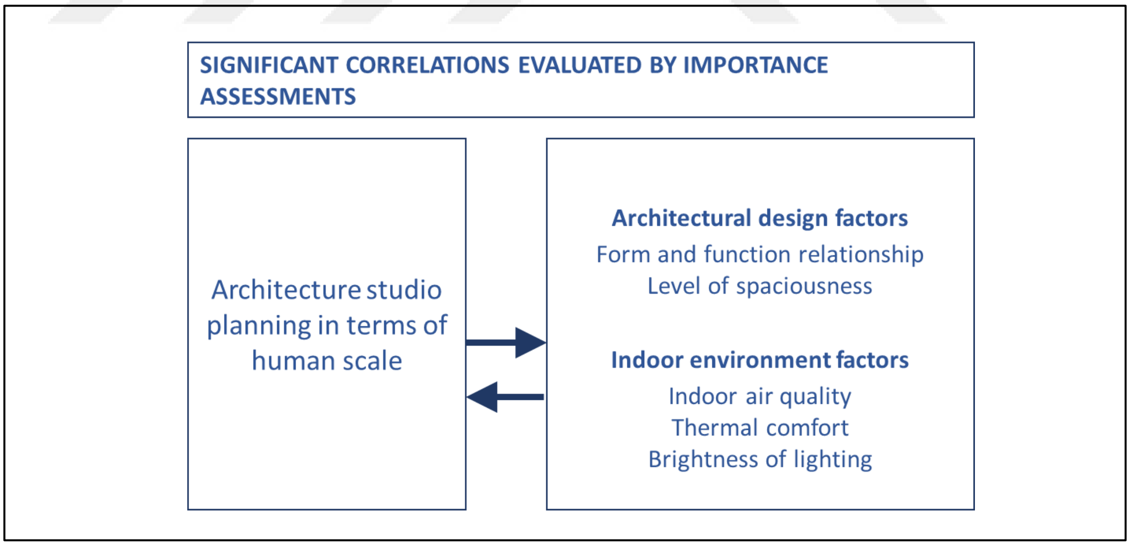
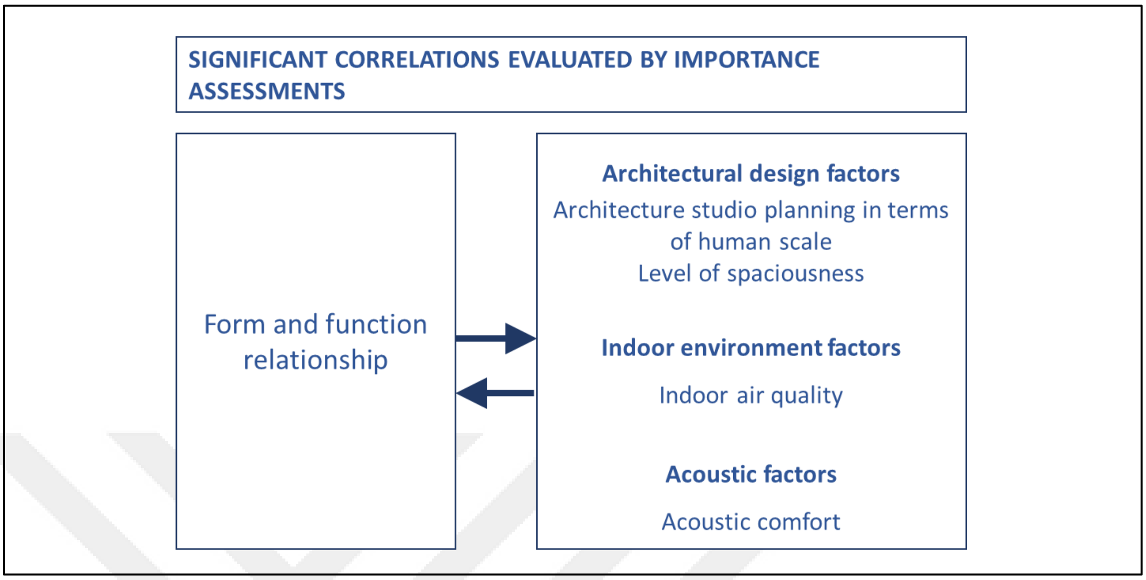


Figure 4.16: Statistically significant correlations between Form and function variable and other space factors evaluated by importance ratings



Besides, the significant connection between acoustic comfort and form and function variable, identify how the level of acoustic comfort in an enclosed entity can influence the importance assessment of architectural design factors. In addition, Figure 4.17 shows that the acoustic comfort feature was also found to be correlated to the acoustic factors, intelligibility of sounds and level of loudness. Other results found in Dokmeci and Kang's (2012b) study, were broadly in line with these findings. They (2012b) have detected a correlation between the level of acoustic comfort with eight different factors which are indoor air quality, thermal comfort, level of loudness, intelligibility of sounds, level of reverberation, ability to locate via sounds, level of crowd, and noise from neighbouring spaces. This indicates the direct impact of the acoustic comfort variable on several space experience factors. Correspondingly, the ability to locate via sounds' factor and its correlation with way finding factor is another result that emphasizes the sound perception and space experience relationship (Figure 4.18).

Figure 4.17: Statistically significant correlations between Level of acoustic comfort variable and acoustic factors evaluated by quality ratings

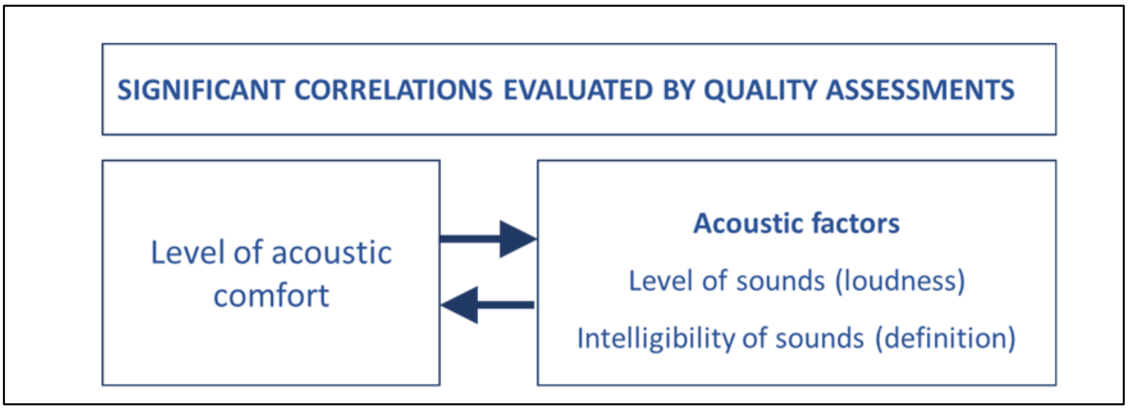
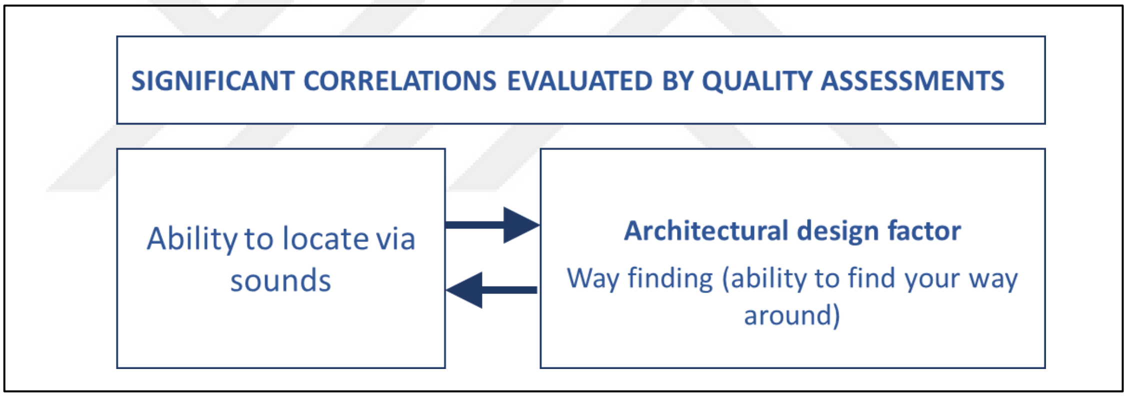


Figure 4.18: Statistically significant correlations between Ability to locate via sounds variable and architectural design factors evaluated by quality ratings



Several statistical findings were presented in the results part concerning different acoustic variables. It has been proved that the quality of reverberation level (Echo) has significant correlations with the level of loudness and intelligibility or definition of sounds, which explains that the quality of each acoustic factor relies on the other one within the environment of the enclosed entity (Figure 4.19). Furthermore, the existing similarities between the quality and importance assessments regarding each of reverberation level and intelligibility of sounds factors, demonstrate the level of consciousness of the users towards their acoustic environment conditions (Figure 4.20).

Figure 4.19: Statistically significant correlations between Level of reverberation variable and acoustic factors evaluated by quality ratings

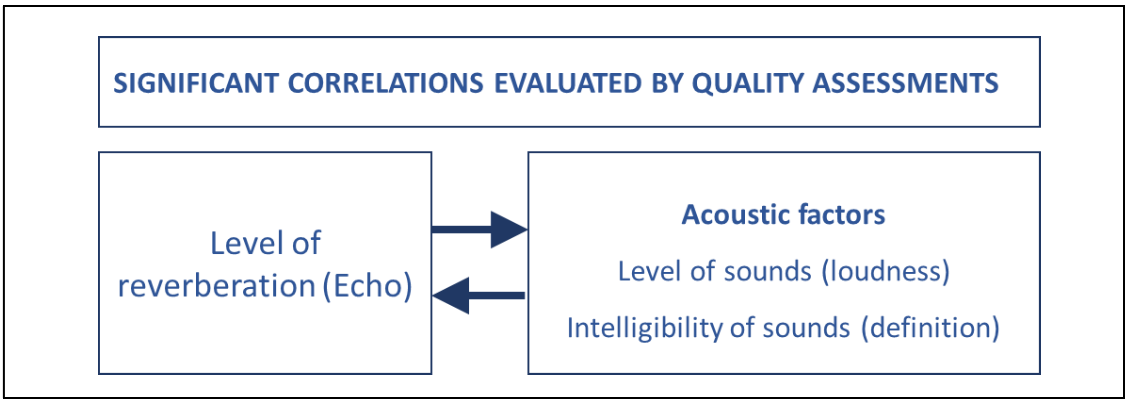
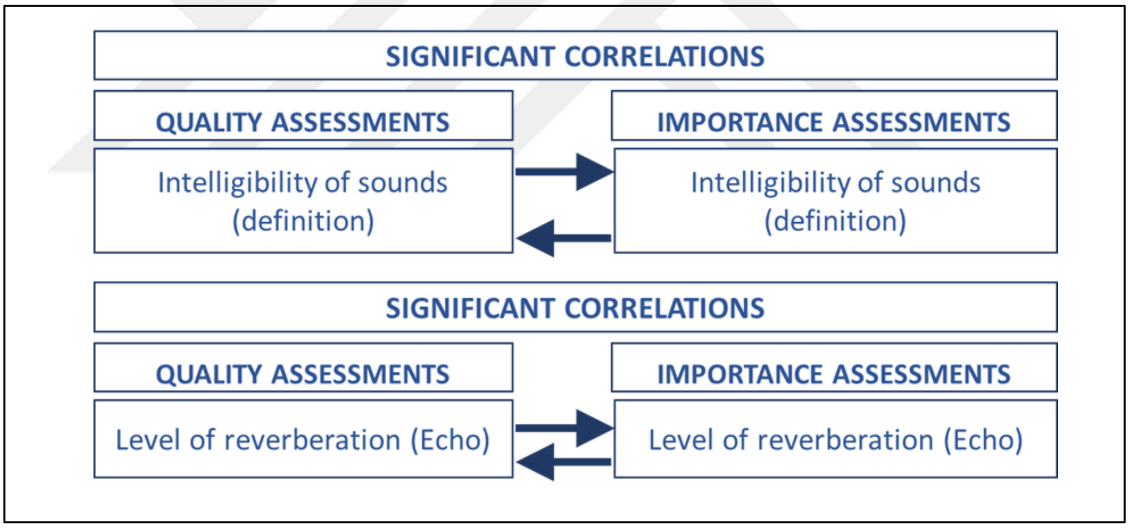


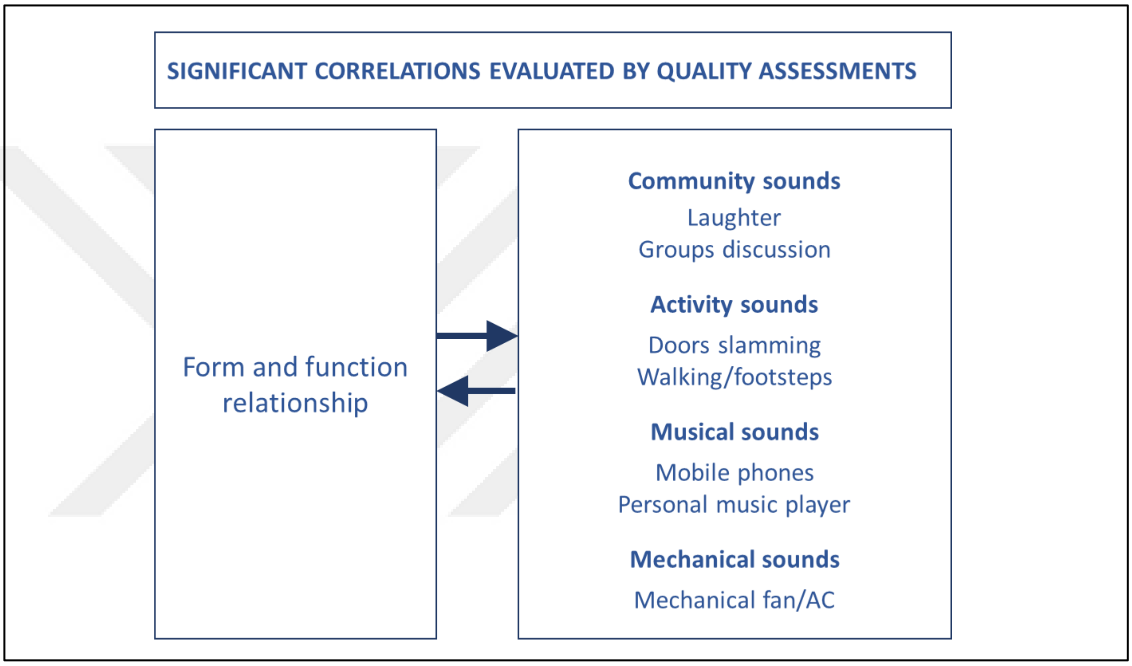
Figure 4.20: Statistically significant correlations between the quality and importance ratings of Intelligibility of sounds variable and Level of reverberation variable



Findings and discussion on the effects of sound sources and space factors on each other

More significant findings were presented in the results section of this study, concerning the quality of different architectural factors that have been identified to be in correlation with several sound sources. Figure 4.21 presents the correlations that has been found between form and function relationship and activity sounds (doors slamming and walking/footsteps), community sounds (laughter and groups discussion), musical sounds (personal music player and mobile phones), and mechanical sounds (mechanical fan/ac). Similarly, the results in Figure 4.22 highlighted that the studio planning in terms of human scale factor was also related to these sound sources, except the sounds of groups discussion and mobile phones. However, this factor also had correlations with more sounds such as model making, page turning, and the overall noise.

Figure 4.21: Statistically significant correlations between Form and function variable and sound sources evaluated by quality ratings



Way finding factor has been rated as one of the factors with the highest quality in the case study, and it has been related to the sound of whispering, overall noise, individual feedbacks, mouse click, and computer keyboard. These sound sources are perceived by the majority of users as not annoying, except for the sound of overall noise. In contrast, the user's density in the space has been rated to be somewhat crowded by the majority. This one has been found to be in relation with more disturbing sound sources. These overall findings may indicate that the architectural design factors are affected by the sound sources perception. In addition to these factors, the indoor air quality that has been rated to have the lowest quality within the examined space features, has been found to be affected by several sound sources including the sound coming from doors slamming which has been indicated as the most disturbing sound in the case study (Figure 4.23).

Figure 4.22: Statistically significant correlations between Architecture studio planning in terms of human scale variable and sound sources evaluated by quality ratings

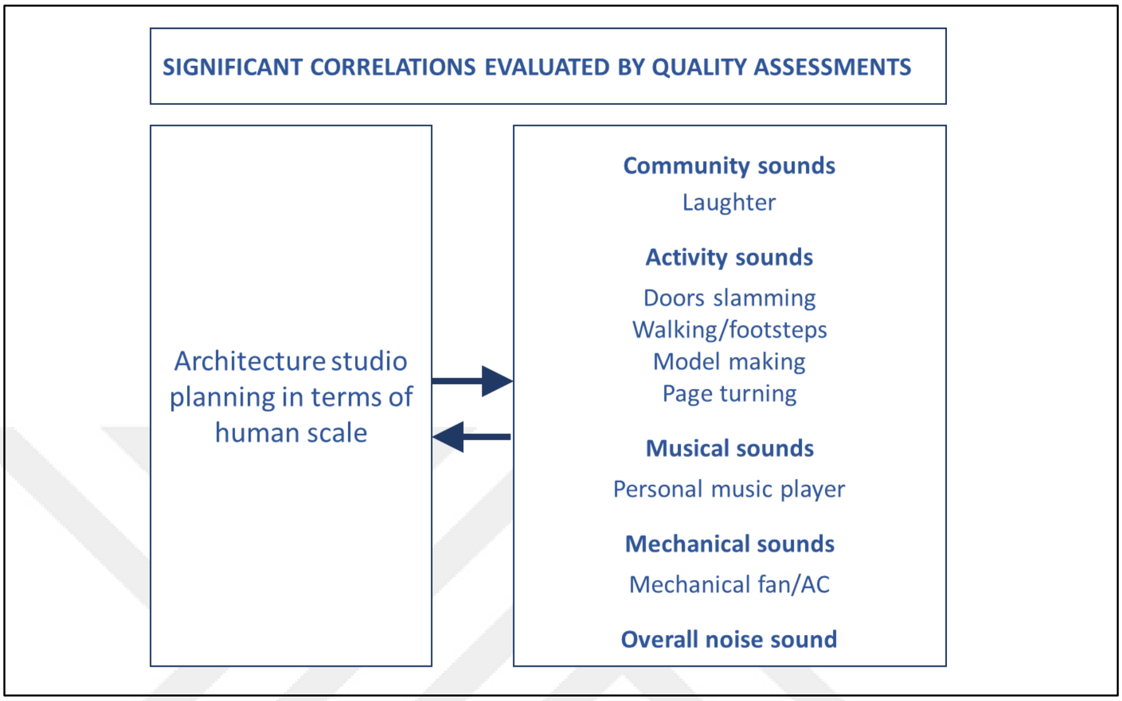
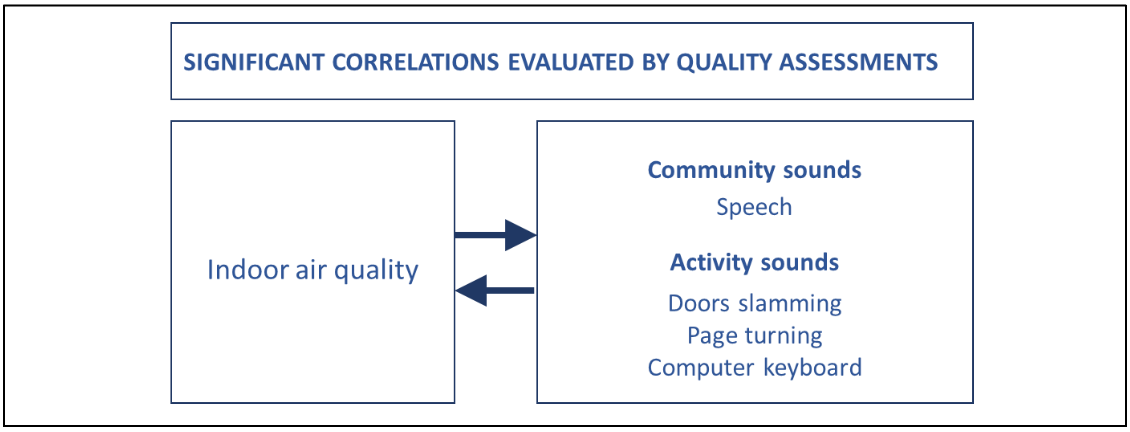
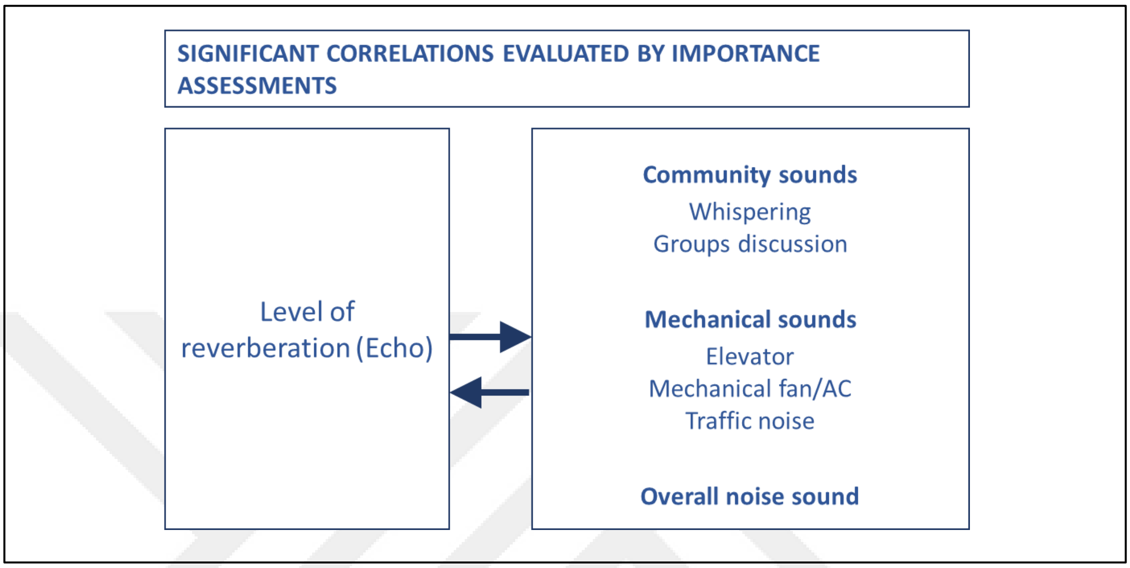


Figure 4.23: Statistically significant correlations between Indoor air quality variable and sound sources evaluated by quality ratings



Similar findings have been presented for the quality assessment of thermal comfort that has been related to activity, community, and overall noise sounds. As shown in Figure 4.24, the importance of the level of reverberation factor was correlated with community, mechanical, and overall noise sounds. These results lead to similar conclusion where the physical factors are also affected by the sound sources perception.

Figure 4.24: Statistically significant correlations between Level of reverberation variable and sound sources evaluated by importance ratings



The sound of laughter has shown significant correlations with seven different factors such as indoor air quality, different sound types, noise from neighbouring spaces, and architectural features (level of spaciousness, form and function, planning in terms of human scale, and level of crowd). This sound source has been selected as the most annoying sound in the case studio. It can be concluded that the identified factors highly affect the auditory perception of the sound of laughter within the studio's soundscape.

Statistical findings regarding the sound source entitled as groups discussion have revealed notable correlations with the importance of different acoustic factors which are ability to locate via sounds, level of reverberation (echo), and acoustic comfort, in addition to brightness of lighting factor, (Figure 4.25). On the other hand, individual feedbacks sound has been perceived as a preferable sound in the studio's soundscape. Figure 4.26 demonstrates how this sound has been found to be correlated with the quality of acoustic variables (level of sounds (loudness), intelligibility of sounds (definition), different sound types), and architectural variables (planning in terms of human scale, and form and function relationship). These results provide evidence that the groups discussion sound is related to the distance between the source and receivers, as they are far from each other, it makes them more affected by the acoustic environment around them. However, during individual feedbacks, the source and receiver tend to be closer to each other and less affected by the acoustic environment. Therefore, the factors of intelligibility of sounds which means the level of definition of the perceived sounds, and the level of sounds which is related to the level of loudness are more reasonable for this context.

Figure 4.25: Statistically significant correlations between Groups discussion sound source and space factors evaluated by importance ratings

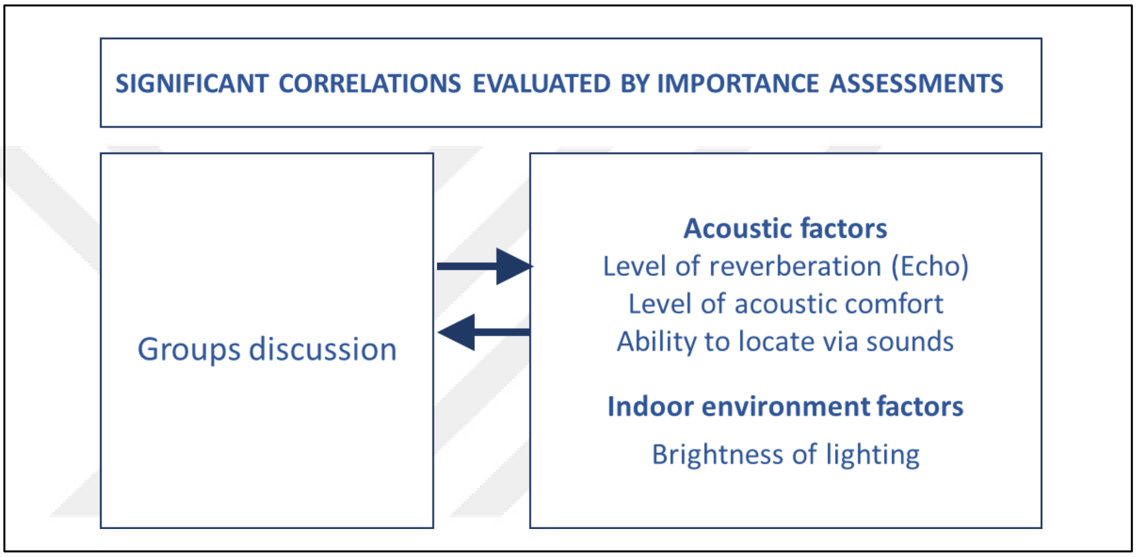
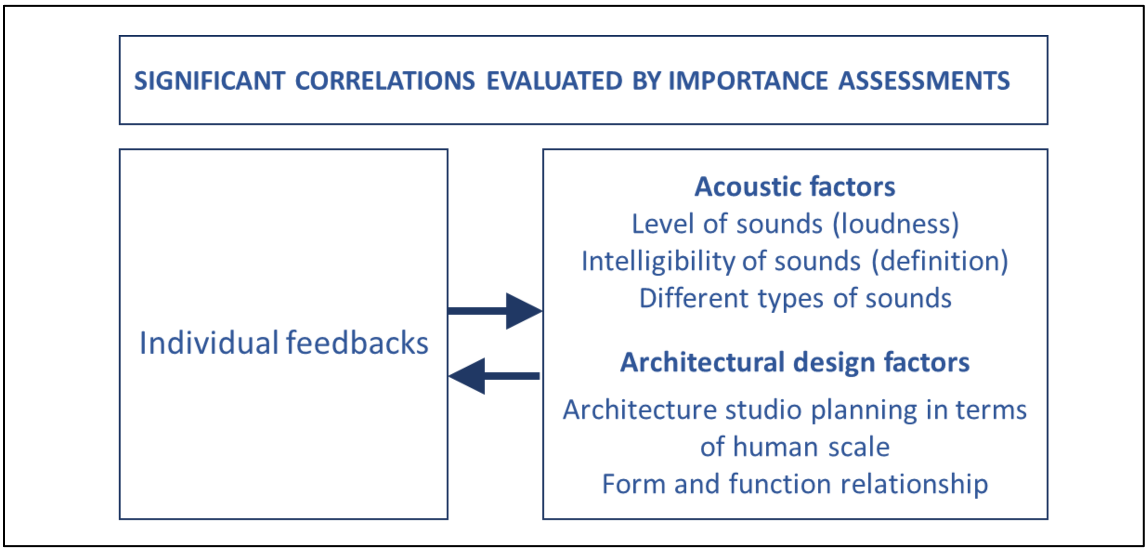


Figure 4.26: Statistically significant correlations between Individual feedback sound source and space factors evaluated by importance ratings



Substantial correlations have been found between the overall noise sound source and factors like ability to locate via sounds, way finding, thermal comfort, level of reverberation or echo, level of crowd (user's density in the space), and studio planning in terms of human scale. There are similarities between the correlations found in this study for overall noise sound and those described by Dokmeci and Kang (2012b). They have demonstrated that the recognised overall noise sound in a library's sonic environment was correlated with several factors which are ability to locate via sounds, way finding, intelligibility of sounds, level of acoustic comfort, and level of sounds. It can be determined that the acoustic perception of the overall noise within an indoor soundscape is affected by several environmental, architectural, and acoustic factors.

Furthermore, doors slamming sound has been found to be correlated with thermal comfort, form and function relationship, and planning in terms of human scale factors. Along with its relation to two low quality rated factors identified as noise from neighbouring spaces and acoustic comfort, this may justify the rankings of this sound source as the most disturbing one within the studio's soundscape, as it has been affected by the other acoustic factors defining the space experience.

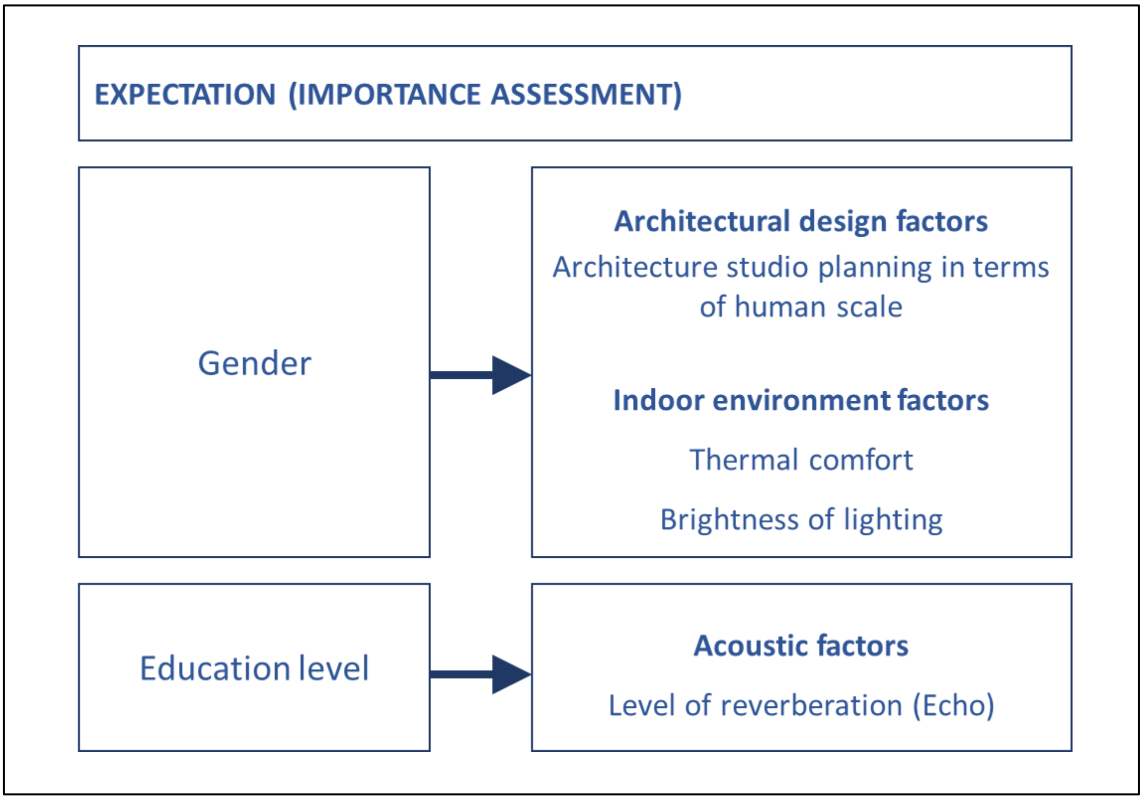
5. CONCLUSION

This thesis focused on evaluating the indoor soundscape of the architecture studios situated in the Faculty of Architecture. Students occupying the architecture studio classrooms and their interaction with the space were the focal point in this research. An adapted framework has been used in this study in order to identify the space factors and sound sources defining the evaluated indoor environment. Through this thesis, factors affecting the sound source perception and space experience within the enclosed environment have been presented and evaluated. An indoor soundscape questionnaire was designed and applied for this research, which included questions from fields like sociology, psychology, acoustics, and architecture. This questionnaire aimed to examine the concepts of space experience and soundscape perception within the architecture studio in Bahçeşehir University.

The process of analysing the acoustic environment of indoor spaces rely upon three fundamental elements which are, the enclosed space, the sound sources, and the receiver. Therefore, investigating the user's profile through demographical factors and their reactions to their environment and sounds can lead to significant findings. The statistical results of all the conducted tests are presented and discussed in this study. Results of the statistical analyses done through the perspective of psychological factors are presented to examine the relation between the assessments given to the case variables and the demographical factors variances. In addition, several patterns were identified according to the statistical evaluations done to identify the interrelations between the factors and sources of the architecture studio.

Significant effects have been identified from gender and education level differences regarding their expectation (importance) of architectural ('studio planning in terms of human scale'), indoor environmental ('thermal comfort' and 'brightness of light') and acoustic ('reverberation level') features (Figure 5.1). Findings have revealed that users' perception of community sounds differ according to their education level. Whereas their perception of activity sounds and mechanical sounds annoyance differ according to their gender. It has been found that senior students were more sensitive to community sounds more than freshman students. The sound of 'individual feedbacks' which was rated as the least annoying sound source in the acoustic environment of the studio was an exception in this finding. In addition, spending long periods of time in the architecture studio did also affect the users' perception of the indoor soundscape. All these findings are summarised in Figure 5.2.

Figure 5.1: Expectation ratings regarding the Importance of the space factors showing demographical variances



Another significant finding in this analysis was the detected awareness level of the students according to their level of education, which influenced their reaction to define the quality of the studio's indoor environmental conditions ('indoor air quality', 'thermal comfort', and 'indoor humidity'). Similarly, community sounds, activity sounds, mechanical sounds, and overall noise sound were perceived differently by the users regarding their education level and gender, which identify the clear variation of demographical factors regarding the reaction to sound disturbance. In Figure 5.3 and 5.4, the summary of these results is presented.

Figure 5.2: Perception ratings regarding the annoyance from sound sources showing demographical variances

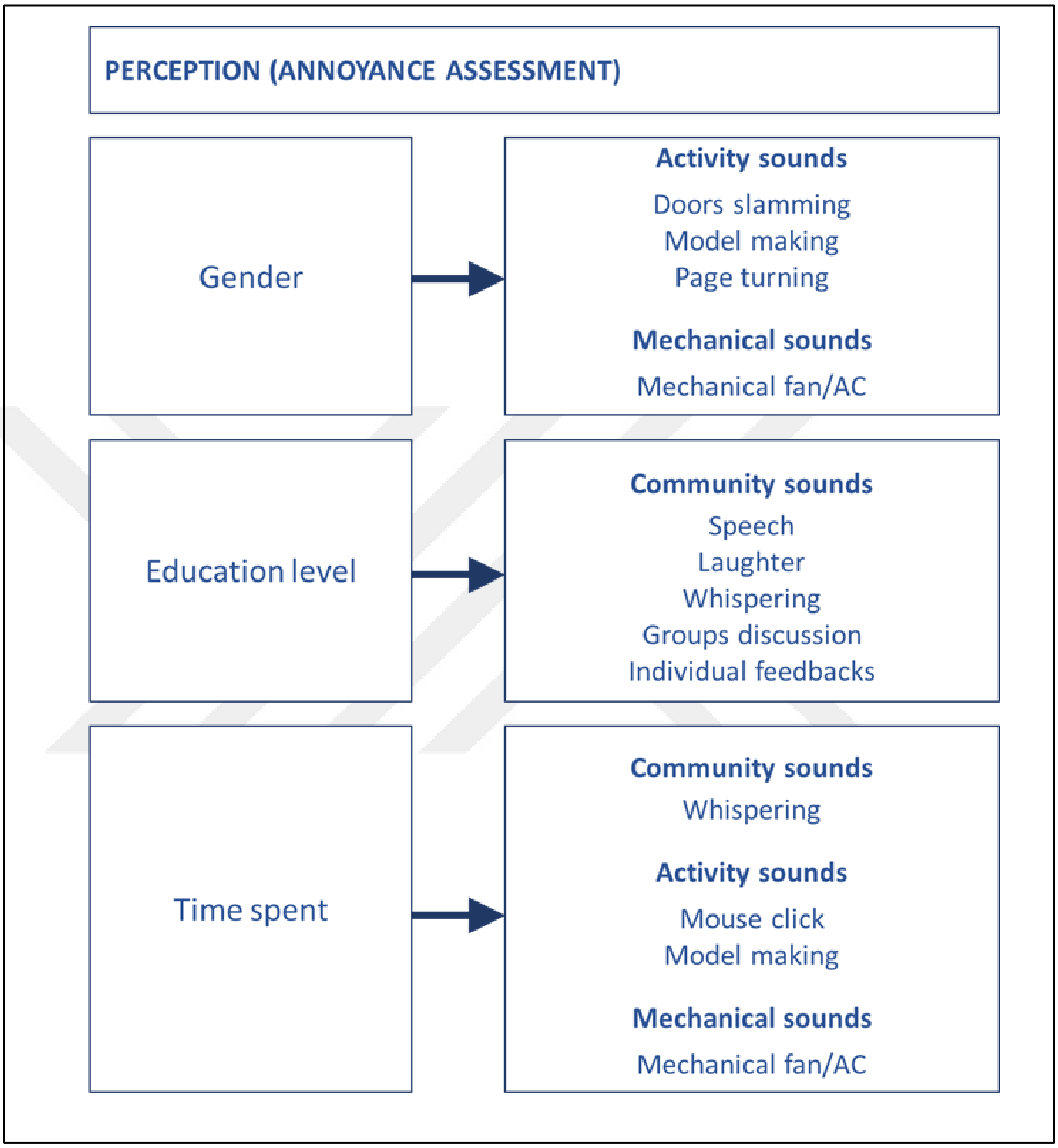


Figure 5.3: Reaction ratings regarding the quality of the space factors showing demographical variances

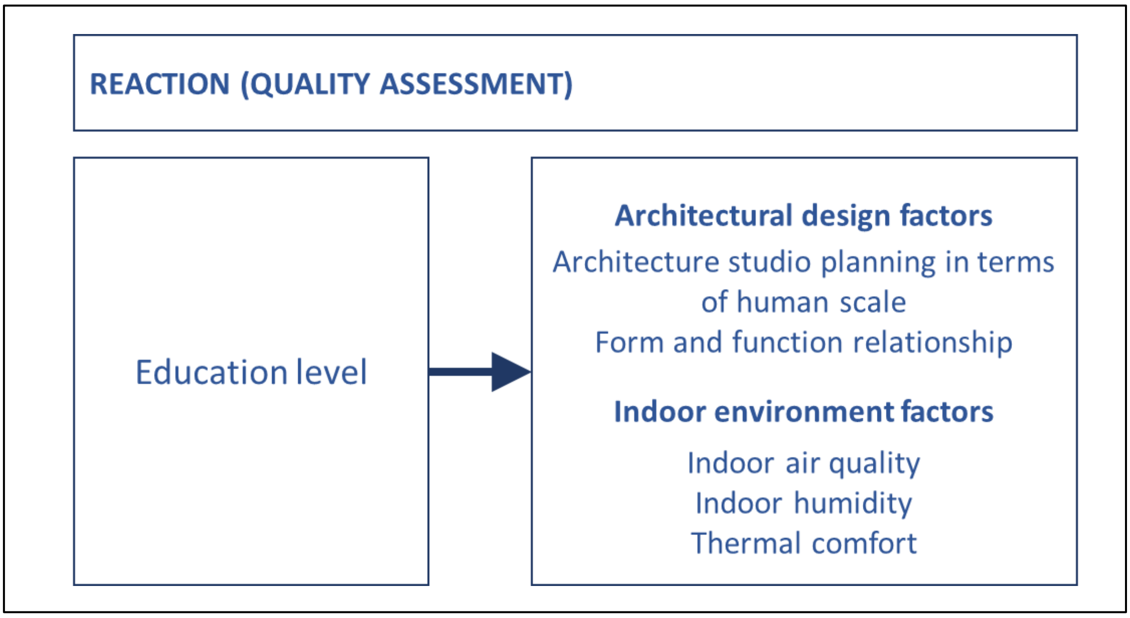
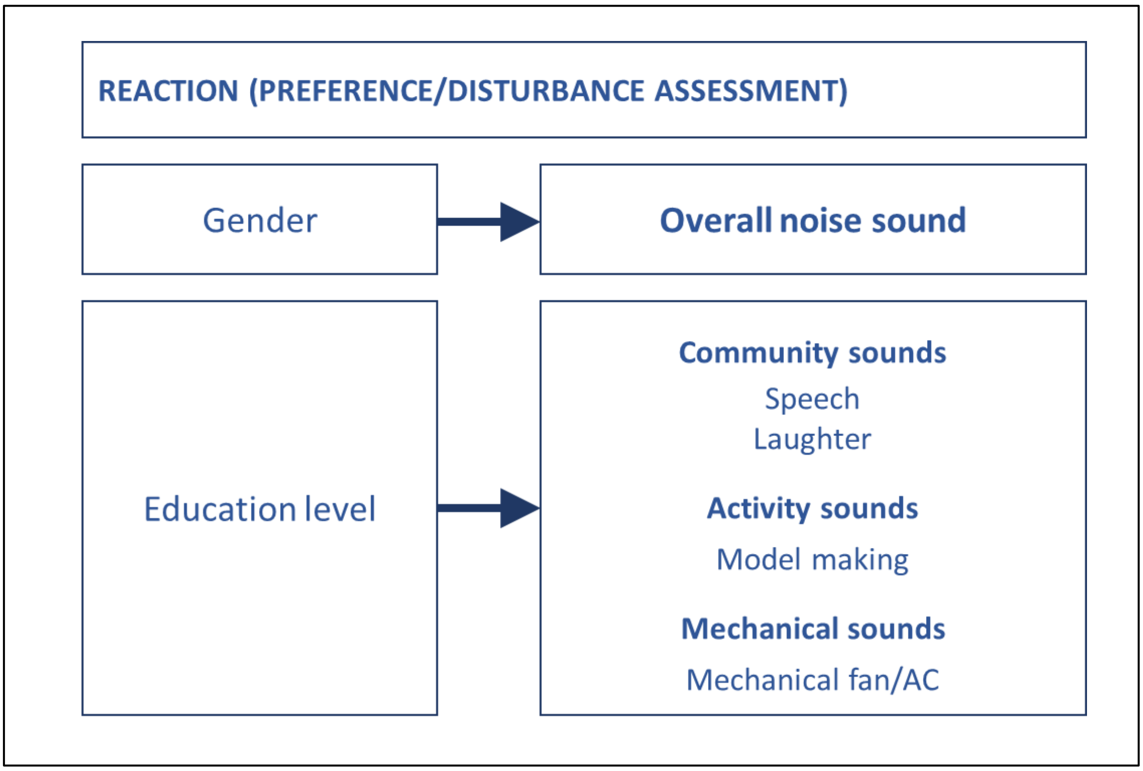


Figure 5.4: Reaction ratings regarding preference/disturbance from sound sources showing demographical variances



In addition to the findings obtained from the demographical differences' evaluation, correlation analysis has presented various themes from the indoor soundscape questionnaire results. Certain space experience variables evaluated through the importance assessment have been found to have significant correlations. 'Architecture studio planning in terms of human scale', 'form and function relationship', and 'indoor air quality' have been related to various architectural design and physical environment features. In addition to these features, 'form and function' variable was related to the acoustic feature as well. On the other hand, these three variables have been found to have different correlations when evaluated according to quality. 'Form and function relationship' variable and 'architecture studio planning in terms of human scale' have been correlated with community, activity, music, and mechanical sound sources. While for 'indoor air quality' variable it was related to activity sounds and community sounds only. Conversely, the quality assessments of 'level of reverberation (echo)' variable was found to be in connection with sound sources which are community sounds, mechanical sounds, and overall noise sound. Whereas the importance of this variable was identified to be related to the acoustic features 'level of loudness' and 'intelligibility of sounds' factors. Figure 5.5 provides a summary of the various correlations related to these four variables. Moreover, more considerable correlations have been found within different acoustic factors, and architectural factors as well. A comparison of these results reveals that the receiver's perception of sounds defining the soundscape has an impact on the quality of the space experience factors. In addition to that, user's expectation regarding architectural and indoor environmental conditions also has an important effect on the indoor experience.

The evaluation of sound sources revealed that 'individual feedbacks' sound has been correlated with architectural and acoustic features, whereas 'groups discussion' sound source has been associated with indoor environment and acoustic conditions. The contrast in this finding is due to the source and receiver relationship during 'groups discussion' that rely more upon the acoustical environment unlike 'individual feedbacks'. Moreover, 'laughter', 'doors slamming', and 'overall noise' sounds have been identified as the most annoying in the architecture studio's sonic environment. As presented in Figure 5.6, these sound sources have been found to have major correlations with architectural design factors, indoor environment factors, and acoustic factors. One of the more significant findings to emerge from this section is that different space experience factors, especially the architectural design factor, affect the user's auditory perception of the sound sources within the enclosed entity.

Figure 5.5: Space experience factors showing statistically significant correlations with other space factors and sound sources

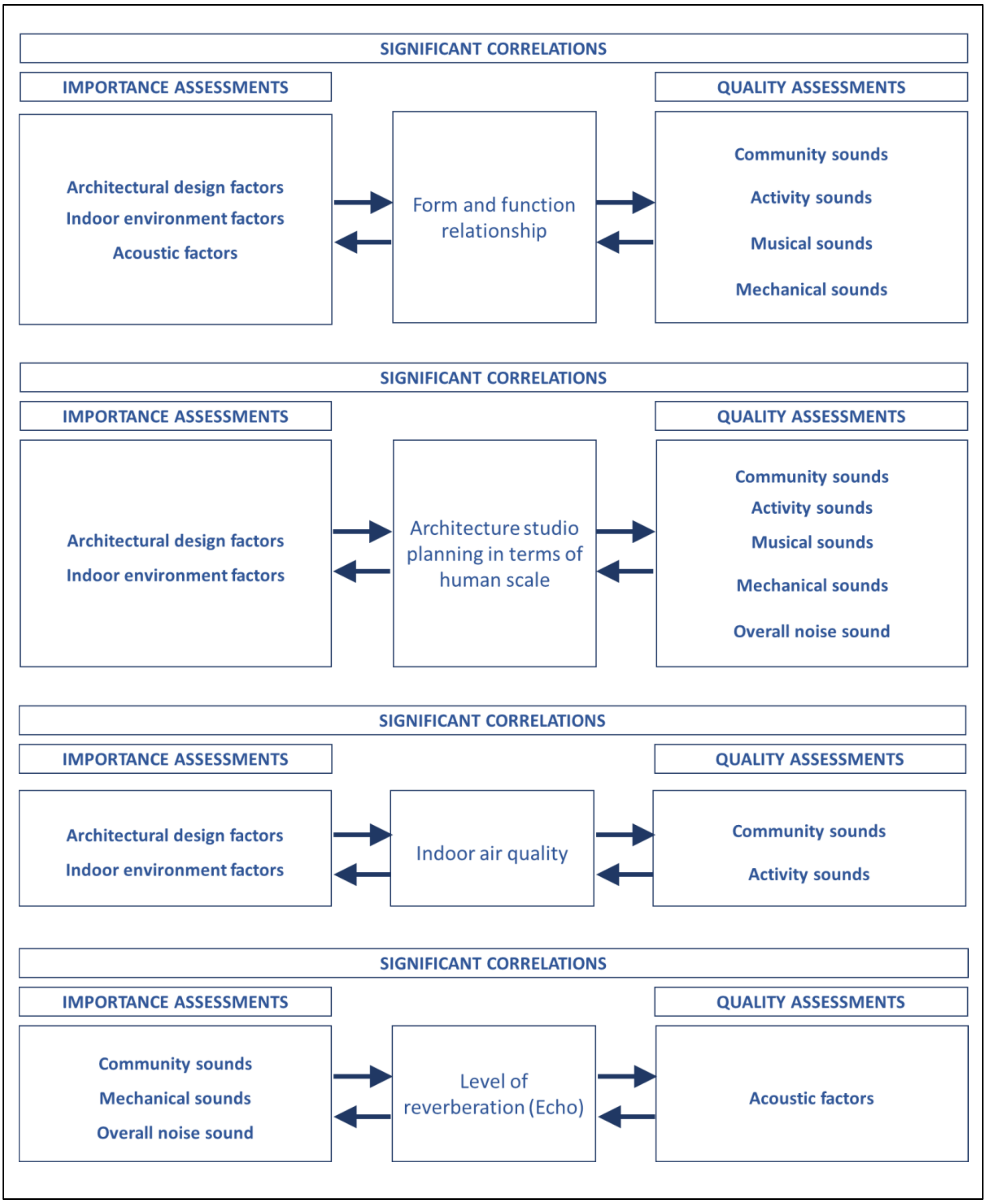
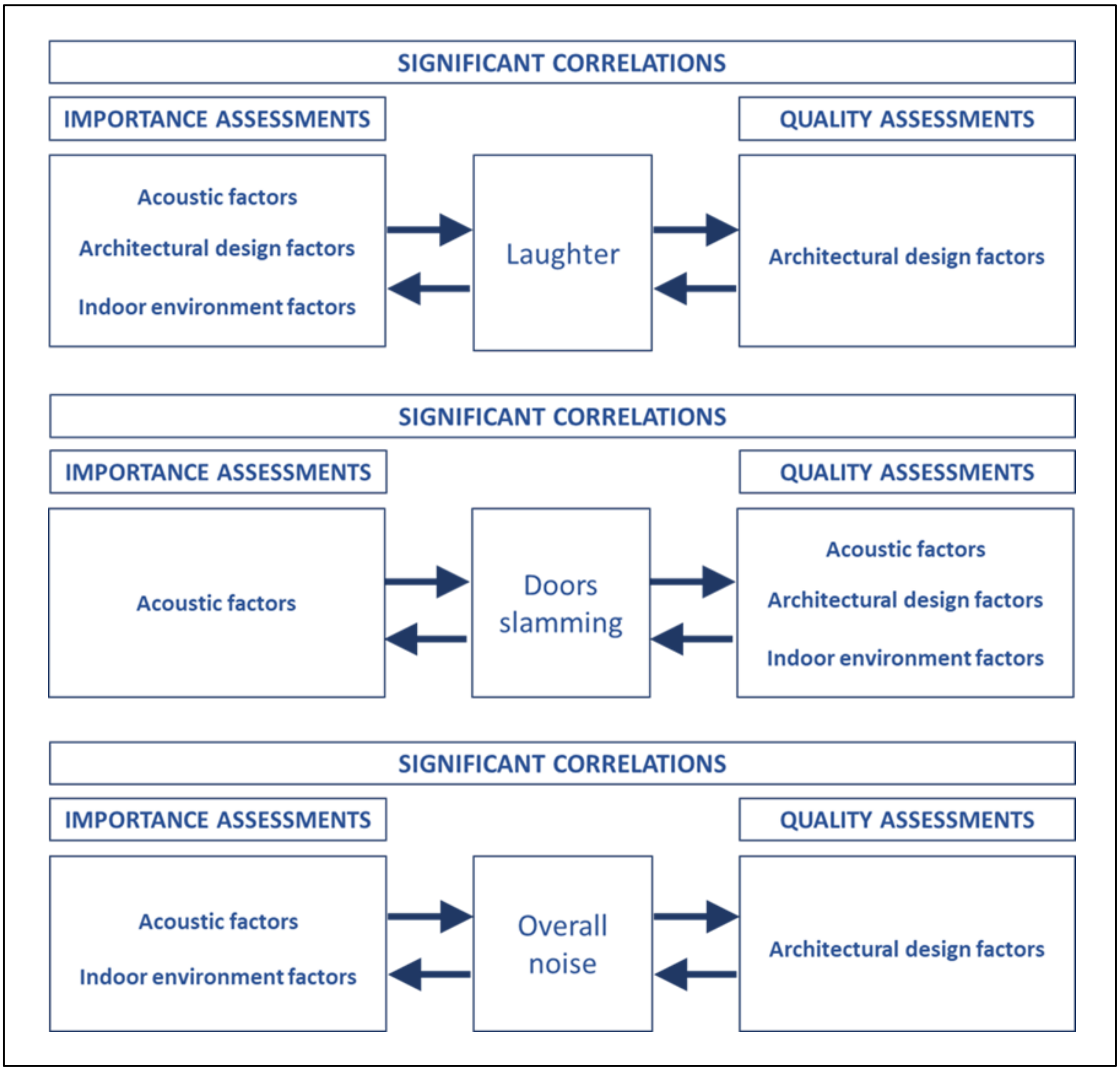


Figure 5.6: Sound sources showing statistically significant correlations with space experience factors



Overall, findings revealed and interpreted in this thesis have first highlighted the effects of demographical factors on the users' perception and experience of their environment, which was one of the notable findings in this study. The relations between the factors defining the experience of the architecture studio and the sound sources defining the indoor soundscape all rely upon the user's assessment and demographics. In addition, various associations that has been found through this indoor soundscape questionnaire stressed several important insights. It has been proved that the user's auditory perception provides significant contributions to the evaluation of the indoor acoustic environment which has an effect on the experience within an enclosed space. Eventually, it can be concluded that the space experience and soundscape perception concepts are notably affected by each other.

The concepts of perception and experience discussed in this study were evaluated subjectively. the statistical results revealed concerning the correlations between sound source perception within each other were saved for further researches. This may provide a good starting point for discussion and further researches. It might be beneficial to use different evaluation approaches that may reveal new findings in future investigations. In addition, similar studies in different enclosed case studies would help understanding the indoor soundscape and may lead to new design strategies to enhance the indoor sound environment and the user's experience in indoor spaces.

REFERENCES

Books

Babbie, E. R., 2010. *The practice of social research*. Belmont, CA, Wadsworth.

Blesser, B. and Salter, L., 2007. *Spaces speak, are you listening? Experiencing Aural Architecture.* The MIT Press.

Bosi, M., Goldberg, R.E., 2003. *Introduction to Digital Audio Coding and Standards*. Springer, Boston.

Fastl, H. & Zwicker, E., 2007. *Psychoacoustics: Facts and Models*. 3rd ed. Springer-Verlag, Germany.

Kang, J., 2006. *Urban sound environment*. London: Taylor & Francis.

Pallasmaa, J., 2005. *The eyes of the skin: Architecture and the scenes.* Wiley, UK.

Schafer, M., 1977. *The soundscape: Our sonic environment and the turning of the world.* Destiny Books, Vermont.

Schulte-Fortkamp, B., And Fiebig, A., 2016. Chapter 4: Impact of soundscape in terms of perception. *Soundscape and the built environment.* pp. 69-85.

Schulz-Dornburg, Julia, 2000. *Art and Architecture – New Affinities.* Gustavo Gili, Brazil.

Periodicals

Abu Eleinen, O., Elrayies, G., and Hussein, R., 2016. A Soundscape Approach for Analyzing and Evaluating Acoustic Environments in Urban Parks. *Portsaid Engineering Research Journal*. Faculty of Engineering–Port Said University. Volume **20**. No. (2).

Aburawis, A., & Dokmeci, P.N., 2018a. An integrated framework on soundscape perception and spatial experience by adapting post-occupancy evaluation methodology. *Building Acoustics*. **25**, pp. 3-16.

Acun, V., and Yilmazer, S., 2018a. A grounded theory approach to investigate the perceived soundscape of open-plan offices. *Applied Acoustics*. **131**, pp. 28–37.

Acun, V. and Yilmazer, S., 2018b. Understanding the indoor soundscape of study areas in terms of users' satisfaction, coping methods and perceptual dimensions. *Noise Control Engineering Journal*. Volume **66**, Number (1), pp. 66-75.

Aletta, F., Botteldooren, D., Thomas, P., Mynsbrugge, T.V., De Vriendt, P., Van de Velde, D., and Devos, P., 2017. Monitoring Sound Levels and Soundscape Quality in the Living Rooms of Nursing Homes: A Case Study in Flanders (Belgium). *Applied Sciences*. **7** (9), pp. 874.

Aletta, F., Kang, J., and Axelsson Ö., 2016. Soundscape descriptors and a conceptual framework for developing predictive soundscape models. *Landscape Urban Plan*. **149**, pp. 65–74. https://doi.org/10.1016/j.landurbplan.2016.02.001.

Babisch. W., 2008. Road traffic noise and cardiovascular risk. *Noise Health*. **10**, pp. 27-33.

Bahali,S. and Bayazıt, N., 2017. Soundscape research on the Gezi Park – Tunel Square route. *Applied Acoustics.* **116**, pp. 260-270.

Ballas J.A., 1993. Common factors in the identification of an assortment of brief everyday sounds. *Journal of Experimental Psychology: Human Perception and Performance*. **19**, pp. 250 – 267.

Brown, L.A., 2012. A Review of Progress in Soundscapes and an Approach to Soundscape Planning. *International Journal of Acoustics and Vibration*. **17**(2). pp. 73-81.

Boya, Y., Jian, K., Hui, M., 2016. Development of Indicators for the Soundscape in Urban Shopping Streets. *Acta Acustica united with Acustica*, **102** (3). pp. 462-473.

Davies, W.J., Adams, M.D., Bruce, N.S., Cain, R., Carlyle, A., Cusack, P., Hall, D.A., Hume, K.I., Irwin, A., Jennings, P., Marselle, M., Plack, C.J., Poxon. J., 2013. Perception of soundscapes: An interdisciplinary approach. *Applied Acoustics*. Volume **74**, Issue (2), pp. 224-231.

De la Prida, D., Pedrero, A., Navacerrada, M.A., Díaz, C., 2018. Relationship between the geometric profile of the city and the subjective perception of urban soundscapes. *Applied Acoustics*. Volume **149**. pp 74-84.

Dokmeci, P.N., and Kang, J., 2016. Analysing Sound Environment and Architectural Characteristics of Libraries through Indoor Soundscape Framework. *Archives of Acoustics*. Vol. **41**, No. (2). pp. 203–212

Dokmeci, P.N., and Kang, J., 2017. Development and testing of Indoor Soundscape Questionnaire for evaluating contextual experience in public spaces. *Building Acoustics*. **24** (4), pp. 307-324.

Dubois, D., Guastovino, C., Maffiolo, V., 2004. The meaning of city noises: Investigating sound quality in Paris (France). *J. Acoust. Soc. Am*. 115.

Dubois, D., 2000. Categories as acts of meaning: the case of categories in olfaction and audition'. *Cognitive Science Quarterly*. **1**, pp. 35 – 68.

Garcia, S.J., Cerdá, S., Montell, R., Romero, J., Cibrian, R., Giménez, A., 2013. Psychoacoustic Parameters as a Tool for Subjective Assessment in Catering Premises. *Advances in Applied Acoustics*. Volume **2** Issue (1).

Gaver, W., 1993. What in the world do we hear? An ecological approach to auditory event perception. *Ecological Psychology*. **5**, pp. 1 – 29.

Ge, J., Kazunori, H., 2004. Research on the sound environment of urban open space from the viewpoint of soundscape-a case study of Saga forest park, Japan. *Acta Acustica United with Acustica*. **90**, pp. 555-563.

Genuit, K and Fiebig, A., 2006. Psychoacoustics and its Benefit for the Soundscape Approach. *Acta Acustica United with Acustica*. Vol. **92**. 1-1

Gozalo G.R., Carmona J.T., Morillas J.B., Gomez, R.V., Escobar, V.G., 2015. Relationship between objective acoustic indices and subjective assessments for the quality of soundscapes. *Applied Acoustics.* **97**, pp 1-10.

Hall, D., Irwin, A., Edmondson-Jones, M., Phillips, S., Poxon, J., 2013. An exploratory evaluation of perceptual, psychoacoustic and acoustical properties of urban soundscapes. *Applied Acoustics*. Volume **74**, Issue (2), pp. 248-254.

Herranz-Pascual K., García I., Aspuru I., Díez, I., Santander, A., 2016. Progress in the understanding of soundscape: objective variables and objectifiable criteria that predict acoustic comfort in urban places. *Noise Mapp*. **3**, pp. 247–263.

Jennings, P., Cain, R., 2013. A framework for improving urban soundscapes. *Applied Acoustics*. Volume **74**, Issue (2), pp. 293-299.

Jeon, J.Y., Hong, J.Y., 2015. Classification of urban park soundscapes through perceptions of the acoustical environments. *Landscape and Urban Planning*. **141**, pp. 100-111.

Kang,J., Aletta, F., Gjestland, T., Brown, L., Botteldooren, D., Schulte-Fortkamp, B., Lercher, P., Kamp, I., Genuit, K., Fiebig, A., Coelho, L., Maffei, L., & Lavia, L., 2016. Ten questions on the soundscapes of the built environment. *Building and Environment*. Volume **108**, Pages 284-294.

Kang, J., and Zhang, M., 2010. Semantic differential analysis on the soundscape of urban open public spaces. *Building and Environment*. **45**, pp. 150–157.

Lindborg, P., 2015. Psychoacoustic, physical, and perceptual features of restaurants: A field survey in Singapore. *Applied Acoustics*. **92**, pp. 47-60.

Liu, F. & Kang, J., 2016. A grounded theory approach to the subjective understanding of urban soundscape in Sheffield. *Cities.* **50**, pp. 28-39.

McGurk, H., MacDonald, J., 1976. Hearing lips and seeing voices. *Nature*. **264**, pp. 746–748.

Mackrill, J., Cain, R., and Jennings, P., 2013. Experiencing the hospital ward soundscape: Towards a model. *Journal of Environnemental Psychology*. Volume **36**, pp.1-8. https://doi.org/10.1016/j.jenvp.2013.06.004.

Miller, N., 2013. Understanding Soundscapes. *Buildings*. **3**, pp. 728-738.

Ou, A., Mak, C.M., Pan, S., 2017. A method for assessing soundscape in urban parks based on the service quality measurement models. *Applied Acoustics*. Volume **127**, pp. 184-193.

Pérez-Martínez, G., Torija, A.J., Ruiz, D.P., 2018. Soundscape assessment of a monumental place: A methodology based on the perception of dominant sounds. *Landscape and Urban Planning*. Volume **169**, pp 12-21.

Porteous, J. D., and Mastin, J. F., 1985. Soundscape. *Journal of Architectural and Planning Research*. **2**, pp. 169–186.

Rehan, R.M., 2016. The phonic identity of the city urban soundscape for sustainable spaces. *HBRC Journal*. **12**, (3), pp. 337-349.

Semidor, C., 2006. Listening to a city with the soundwalk method. *Acta Acustica united with Acustica.* **92**, pp. 959–964.

Semiha, Y., and Zeynep, B., 2017. Understanding the indoor soundscape in public transport spaces: A case study in Akköprü metro station, Ankara. *Building Acoustics,* Vol. **24** (4), pp. 325–339. https://doi.org/10.1177/1351010X17741742

Sudarsono, A.S., Lam, Y.W., Davies, W.J., 2017. The validation of acoustic environment simulator to determine the relationship between sound objects and soundscape. *Acta Acustica United with Acustica*. **103** (4) , pp. 657-667.

Sun, K., De Coensel, B., Filipan, K., Aletta, F., Renterghem, T.V., De Pessemier, T., Joseph, W., Botteldooren, D., 2018. Classification of soundscapes of urban public open spaces. *Landscape and Urban Planning.* Volume **189**, pp. 139-155.

Truax, B., and Barrett, G.W., 2011. Soundscape in a context of acoustic and landscape ecology. *Landscape Ecology.* **26** (9).

Truax B., 1996. Soundscape, acoustic communication and environmental sound composition. *Contemp Music Rev.* **15** (1–2), pp. 49–65.

Watts, G., Khan, A., and Pheasant, R., 2016. Influence of soundscape and interior design on anxiety and perceived tranquillity of patients in a healthcare setting. *Applied Acoustics*. **104**, pp. 135–141.

Xiao, J., and Hilton, A., 2019. An Investigation of Soundscape Factors Influencing Perceptions of Square Dancing in Urban Streets: A Case Study in a County Level City in China. *International Journal of Environmental Research and Public Health.* **16** (5), 840.

Yang, W., & Kang, J., 2005a, Soundscape and Sound Preferences in Urban Squares: A Case Study in Sheffield. *Journal of Urban Design*. **10**. (1), pp. 61–80.

Yang, W., Kang J., 2005b. Acoustic comfort evaluation in urban open public spaces. *Applied Acoustics.* **66,** pp**.** 211 – 229.

Zhang, X., Ba, M., Kang, J., Meng, Q., 2018. Effect of soundscape dimensions on acoustic comfort in urban open public Spaces. *Applied Acoustics*. **133**, pp. 73–81.

Zhang, M., Kang, J., 2007. Towards the evaluation, description, and creation of soundscapes in urban open spaces. *Environment and Planning B: Planning and Design*. **34**, pp. 68 – 86.

Other Publications

Aburawis, A., & Dokmeci, P.N., 2018b. Occupant experience of indoor soundscapes in university office spaces. *Euronoise 2018* - Conference Proceedings.

Adams, M.D., Davies, W.J., and Bruce, N.S., 2009. Soundscapes: an urban planning process map. *In: Proceedings of the Inter Noise*. August 2009, Ottawa, Canada.

Baker, J., 1986. The role of the environment in marketing services: The consumer perspective, In J. Czepiel, C. Congram, & J. Shanahan (Eds.), The services challenge: Integrating for competitive advantage (pp. 79-84).

Brown, L.A., 2011. Advancing the concepts of soundscapes and sound-scape planning. *Australian Acoustical Society Conference.* Acoustics 2011: Breaking New Ground.

COST TUD Action TD-0804 Soundscape of European Cities and Landscapes. 2013, March 22.

Davies, W.J., Adams, M., Bruce, N.S., Cain, R., Jennings, P., Carlyle, A., Cusack, P., Hume, K., Plack, C., 2009. A positive soundscape evaluation tool. *EURONOISE.* Edinburgh, Scotland.

De Ruiter E., 2004. Reclaiming Land from Urban Traffic Noise Impact Zones. *The Great Canyon PhD dissertation.* Technical University of Delft.

Dokmeci, P.N., and Kang, J., 2012a. Indoor soundscape analysis of enclosed public and commercial spaces with soundwalk method. *Inter-Noise 2012*. Volume **8**, pp 6462-6469.

Dokmeci, P.N., Kang, J., 2012b. A comparative case study of indoor soundscape approach on objective analyses and subjective evaluations of libraries. *Société Française d'Acoustique.* Acoustics, Apr 2012, Nantes, France.

Dokmeci, P.N., Kang, J., 2001. *Indoor Soundscaping of Public Enclosed Space.* http://www.jtdweb.org/journal/2011/01_%20Papatya%20Nur%20Dokmeci.pdf

Dokmeci, P.N and Kang, J., 2010. Objective parameters for acoustic comfort in enclosed spaces. *Proceedings of 20th International Congress on Acoustics*. 2010, 23-27 August. Sydney, Australia.

Fiebig, A., and Schulte-Fortkamp, B., 2004. The Importance of the Grounded Theory with Respect to Soundscape Evaluation. *Proceedings of the Joint Congress CFA/DAGA'04*. March 22-25, 2004 - Strasbourg, FRANCE

Genuit, K. and Fiebig, A., 2005. Prediction of Psychoacoustic Parameters. *Noise Conference*. October 2005 Minneapolis, Minnesota. pp. 17-19.

Hedfors, P., 2003. Site Soundscapes, Landscape Architecture in the Light of sound, *Doctoral thesis*. Swedish University of Agricultural Sciences, Sweden.

Herranz-Pascual, Karmele & Aspuru, Itziar & Garcia, Igone. (2010). Proposed Conceptual Model of Environmental Experience as Framework to Study the Soundscape. *Internoise 2010*. September 2010. Lisbon.

Hidayetoglu, M. L., YILDIRIM, K., & Çağatay, K., 2010. The effects of training and spatial experience on the perception of the interior of buildings with a high level of complexity. *Scientific Research and Essays*. **5**.

Ikhwanuddin, R., Sarwono,J., Sudarsono, A.S., Utami, S.S., 2017. Library Soundscape: Higher Education Students' Perception. *Inter Noise 2017*. August 2017. Hong Kong.

International Organization for Standardization. 2014. ISO 12913-1:2014 Acoustics — Soundscape — Part 1: Definition and conceptual framework. Geneva: ISO.

Kinayoglu G., 2009. The role of sound in making of a sense of place in real, virtual and augmented environments. *Berkeley*. University of California Press.

Maffiolo, V., David, S., Dubois, D., Vogel C., Castellengo, M., Polack J.D., 1997. Sound characterization of urban environment. *Proceedings of Inter-noise 97*. Budapest, Hungary.

Offenhuber, D., Auinger, S., 2013. *Urban Configuration and the Soundscape*. https://www.stadtmusik.org/wp-content/uploads/2013/03/Configurational-Aspects-of-Soundscapes.pdf

Osgood, C. E., Suci, G. J., Tannenbaum, P. H., 1957, The measurement of meaning. University of Illinois Press. Urbana.

Psychoacoustics. https://en.oxforddictionaries.com/definition/psychoacoustics.

Rodríguez-Manzo, Fausto E., Garay-Vargas, Elisa, 2010. Proceedings of the international symposium on room acoustics. Melbourne, Australia. pp. 29-31.

Solomon J., 2012. Building the soundscape in the age of visual distraction. *Thesis Book.* Submitted for Bachelor of Architecture at Syracuse University.

Song, X., Cho, T.D., Piao, Y.J., 2012. Semantic Differential Analysis of the Soundscape in Urban Park. *Journal of the Environmental Sciences*.

Steele, D., Bild, E., Tarlao, C., Martín, I.L., Cubero, J.I., Guastavino, C., 2016. A comparison of soundscape evaluation methods in a large urban park in Montreal. *Proceedings of International Congress on Acoustics.*

Volkan, A., and Semiha, Y., 2017. Identification of individuals' emotional response to the indoor soundscape in public study areas via semantic differentiation. *Inter-Noise 2017*. 46th International Congress and Exposition on Noise Control Engineering.

Zeitler, A., Hellbrück, J., 2001. Semantic attributes of environment sounds and their correlations with psychoacoustic magnitudes. *In Proceedings of the 17th international congress on acoustics*. Italy, Rome.

Zhang, S., Meng, Q., Kang, J., 2016. The influence of crowd density on the evaluation of soundscape in typical Chinese restaurants. *Inter-Noise 2016*. Hamburg. Pp 6150-6155.